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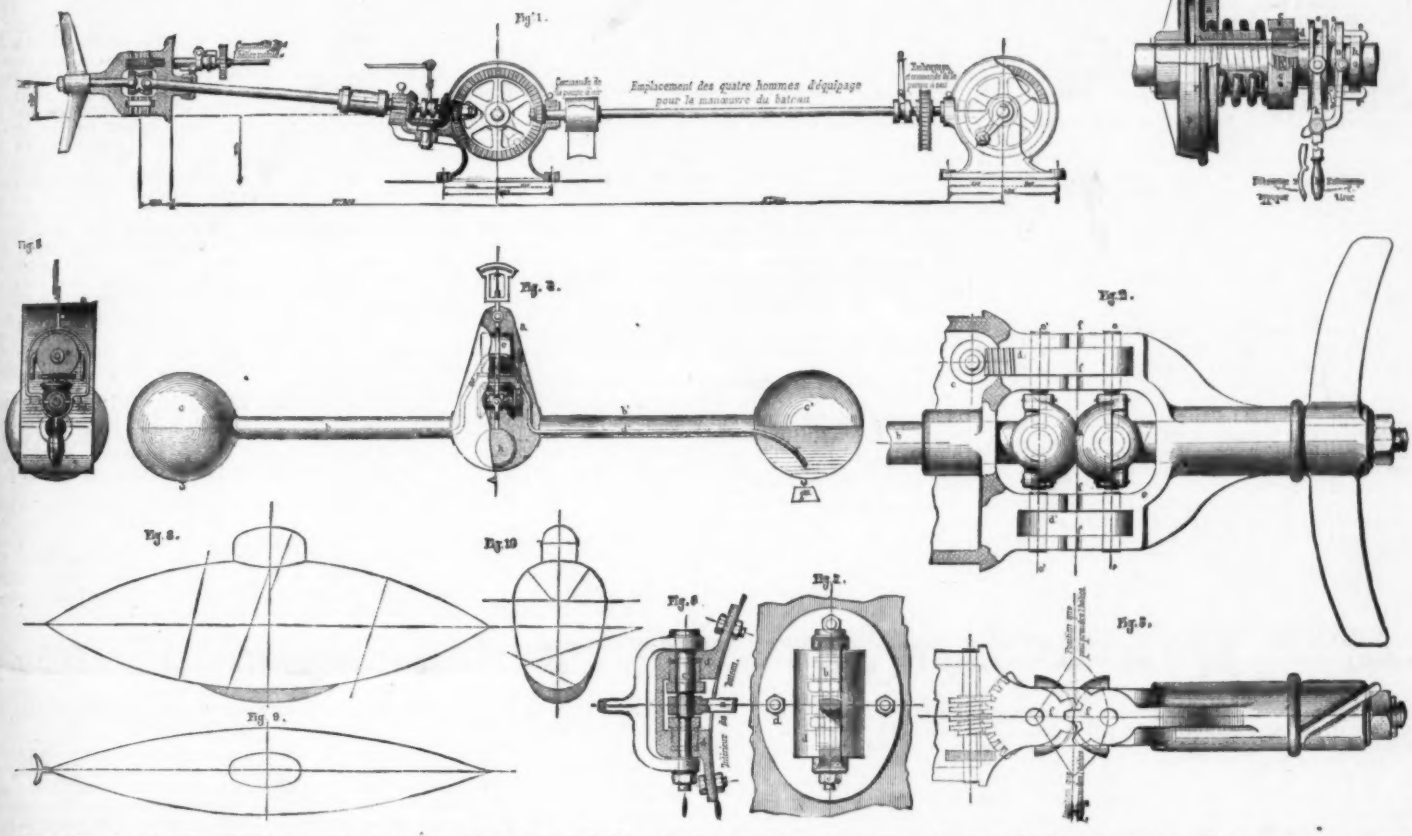

PLATE II.—FIG. 1.—Gearing for Maneuvering the Movable Helix by Pedals. FIGS. 2 AND 3.—Elevation and Plan of the Movable Helix. FIGS. 4 AND 5.—Apparatus to prove the Perfect Equilibrium of the Boat. FIGS. 6 AND 7.—Arrangement of the Oar Hinge. FIGS. 8 TO 10.—Geometrical Outlines of the Boat (Scale 1-30). FIG. 11.—Automatic Friction Coupling.

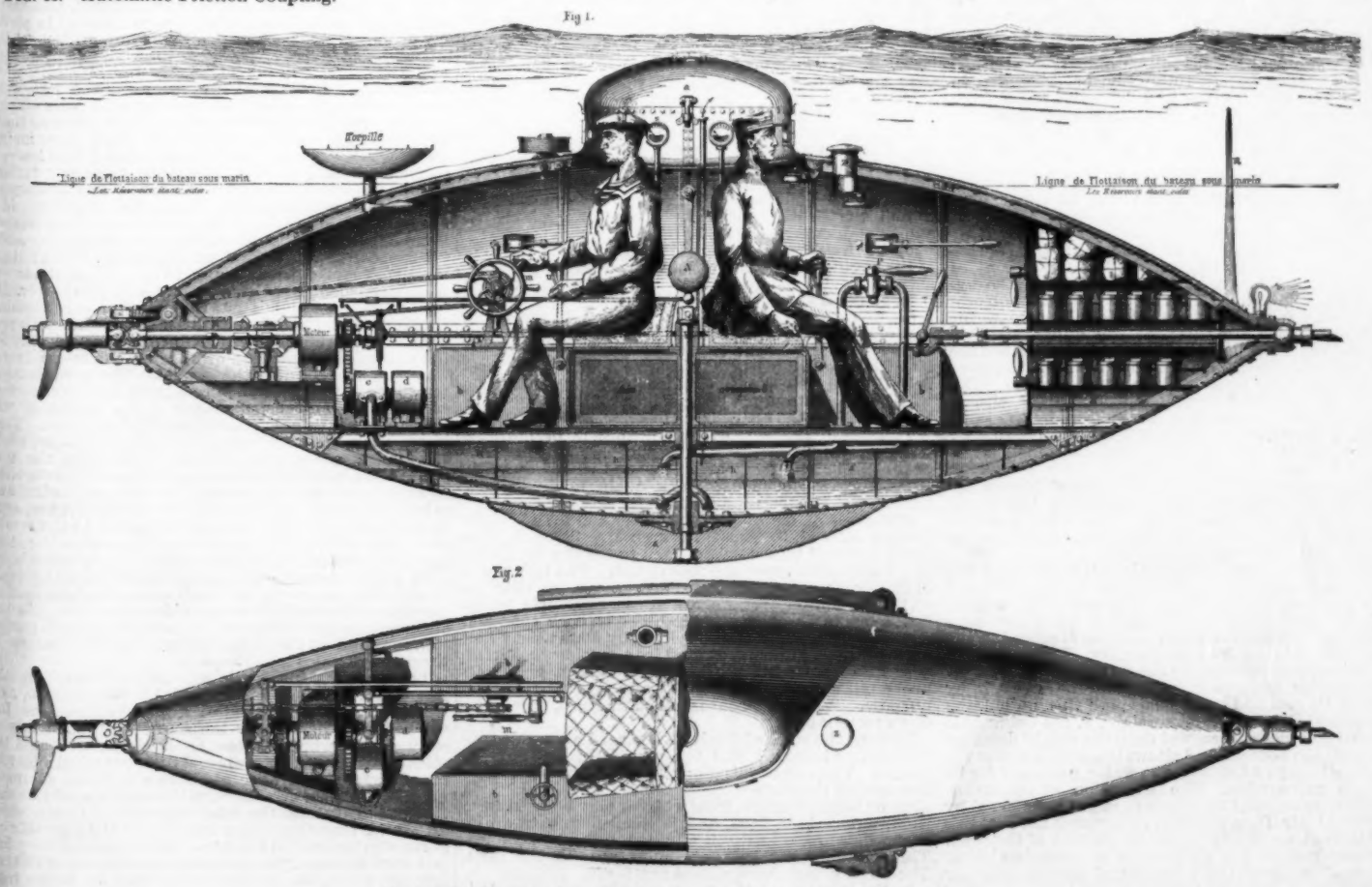

PLATE I.—FIG. 1.—Longitudinal Section (Scale 1-10). FIG. 2.—Plan.

GOUBET'S SUBMARINE TORPEDO BOAT.

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THE experiments recently made in Denmark with a new style of submarine torpedo boat showed by the number of engineers who were present how great importance attaches to this subject in the eyes of all naval powers. The experiments alluded to were made with a recent invention of Mr. Goubet's, which we illustrate herewith.

The mechanism of this boat is not an experimental one, but rather an improvement upon that purchased from the inventor in 1881 by the Russian Government, which, after a year of experiments, ordered machinery for 300 submarine torpedo boats from Mr. Goubet. Encouraged by this result, Mr. Goubet has since devoted himself to improving his work, and has finally produced a boat which is remarkable for the ease, quickness, and safety with which it way be maneuvered.

The principal obstacle to the running of a submarine boat is its want of stability. In fact, after the complete submersion of the boat, its equilibrium may be destroyed by the least shifting of the internal weight. In order to counteract this, the submarine boats furnished to Russia were provided with an internal weight which was shifted by means of a screw maneuvered by a hand-wheel within reach of the first pilot. But this did not work quickly enough, and gave too imperfect results, and so the trouble was remedied by an entirely new combination.

The apparatus shown in Figs. 4 and 5 (Plate II.) proves the exactness of what precedes. Fig. 4, which exhibits half the apparatus in section, shows that it consists of a shell, *a*, and of two tubes, *bb'*, each terminating in a hollow sphere, *cc'*, containing a certain quantity of water. Each sphere is at the same distance from the shell, *a*, and the whole is suspended by a cord. A pipe, *dd'*, enters each of these spheres, and is connected with a double acting pump, *e*, in the shell. Lower down there are two gearings, one of which actuates the pumps. These communicate with an intermediate gearing designed to change the direction of the pump's revolution, according as the coupling box, *f*, between them actuates one or the other. This coupling box, *f*, is controlled by a lever, *i*, fixed to the upper part of the shell and carrying a disk, *h*, at its lower part. The coupling box slides freely upon the shaft. The apparatus is balanced by the two spheres, each containing two pounds of water.

This granted, let us suppose that the coupling box is actuated by a central spring or any other means, and in this position of perfect equilibrium is held by a stop fixed to the shell. If, now, we add a two pound weight to the hook of one of the spheres, the entire apparatus will tilt toward the loaded side, and the gearing on this same side will connect with the box, *f*, and this latter, freed from its stop, and held at the same point by the disk, *h* (that does not move), will actuate the pump, and the pump will force some of the water contained in the depressed sphere into the one that is lifted. If, in one revolution, the pump sucks up a pound of water, it is evident that the equilibrium will be at once established again, and the rotary motion of the coupling box will be arrested by its stop.

If the two pound weight be removed, a contrary motion will occur, and an equilibrium be again established. The disk, A (Fig. 1), in the torpedo boat answers exactly the same purpose through its stability, by causing the right or left gearing of the double acting pump, *e*, to be in contact with the coupling box when the least inclination of the boat occurs, thus preventing sensible variations in the desired position as to depth. In fact, the helix here makes 180 revolutions per minute, and the speed of the boat is five knots per hour, thus giving three revolutions per second at a speed of nine feet. Now, it is evident that, according to the capacity of the pump which shifts the water contained in the two reservoirs, AA', at each extremity of the boat, an equilibrium will be quickly established before the boat has perceptibly risen or descended in the short time that it takes to pump the water from one reservoir to the other. This automatic apparatus performs exactly the same office as a balance, and operates even when the helix is out of gear and the boat is stationary.

Signal Fusee.—The crew is provided with a means of showing the exact location of the boat, and of calling for aid or explanations. As the boat does not go to great distances from the ship or port to which it belongs, it is provided with a small apparatus, Z, consisting of a tube closed by two caps. This is in front of the dome, *d*, and does not project much above the top of the boat. This tube serves for the introduction of a signal fusee. When, from the interior of the boat, the fusee is introduced into this tube, the upper cap is in place, and prevents the introduction of water. When the lower cap is in place, the upper one is off and the fusee rises, and explodes upon reaching the surface. The noise of the explosion is proportioned to the charge used. At night, colored fires are sent up by the same method to show the depth at which the boat is situated. The crew can also communicate with the ship that is signaled by these means by sending up a telephone wire by means of a small buoy. In case of maneuvering within range of the ship, a continuous telephonic communication may be kept up. The small quantity of water that takes the place of the fusee is led to the reservoir, HH', by a small pipe.

Safety-weight.—The safety-weight is fixed under the boat by a steel rod, *g*, terminating in a nut. This rod enters the boat through a shipping box. The weight, which is equal to that of the bulk of water necessary to submerge the boat to a given depth, is placed in the center, and adds much to the stability. Let us suppose that an accident happens to the water pump, C; then the maneuver consists in revolving the screw, *g*, by means of its nut and lever. Through this motion, the nut embedded in the safety-weight, *x*, not being able to revolve, becomes unscrewed until the weight detaches itself from the bottom, and allows the boat to rise to the surface, although filled with the water necessary for its complete submersion. The expulsion of the water, which is here effected by a pump, might be effected by compressed air from the reservoir, were it not that this was reserved especially for the respiration of the crew. Such sole use of the air permits of remaining longer submerged without the necessity of having large air reservoirs, and thus increasing the weight and size of the boat, as well as that of the motor.

Aeration of the Boat.—The pressure of the air in the boat must always be kept up to about one atmosphere. Diminution of the pressure is not to be feared, but an increase of it must be avoided. Mr. Paul Bert, in fact, has demonstrated that air under a pressure of two atmospheres exercises a toxic effect upon the living economy.

Let us admit that the capacity of the air reservoir is 1¾ cubic feet (the capacity is in reality much greater), and that the air be compressed therein to fifty atmospheres; then its weight will be about:

$$\frac{50\times1,293\times760}{760}=81\tfrac{1}{4}\text{ lb.}$$

The weight of oxygen in reserve will be about 18 ounces. Now 9 drachms suffice for one man, and 18 ounces per hour would permit him to live seventeen hours. The two men, then, with a 1¾ foot reservoir of air compressed to 50 atmospheres, could live for 8 hours. During this period they would exhale 21 ounces of carbonic acid and an indefinite quantity of animal matter. The carbonic acid may be absorbed by 3 pounds of caustic potash, and the animal matter by a slight disengagement of chlorine from chloride of lime.

Electric Motor.—The application of electricity to drive the helix and pumps necessitates a slight increase in the size of the boat. The power necessary is 304 foot-pounds for a speed of 5 knots per hour when the boat is submerged. The compressed air reservoirs are calculated to furnish the air necessary for the officer and his subaltern for at least ten hours.

The Siemens dynamo used weighs about four hundred pounds, and takes up but little room. It runs with a tension of 48 volts, and thus necessitates 24 accumulators. Prudence requires 25 per cent. more in reserve, so that the total number carried is 30. Their weight, as a whole, is 4,000 pounds.

The Helix.—The system of movable helix employed consists in the arrangement of a hinge joint between the boat and the movable support of the rudder helix. This joint is so arranged that when the helix is turned the angle of its deflection with respect to the joint is the same as that which the latter makes with the axis of the boat. This equality of the angle is the essential condition for obtaining a regular motion through hinge-joints.

Fig. 2 (Plate II.) represents an elevation of the stern of a boat provided with this system of movable helix, and Fig. 3 shows a plan of it. The helix is held by a support, *e*, hinged to the boat's stern-post. The lower hinge, *d'*, serves only as a turning joint, while the upper, *d*, is prolonged, and forms a lever for swinging the helix. To this effect it terminates at *o'* in a gear wheel actuated by an endless screw, C. The fixed part of the rudder carries a toothed sector, *f*.

With this system the engine shaft undergoes no longitudinal stress, and the helix is capable of moving a quarter revolution on each side of the shaft that actuates it, while the motion remains regular.

The coupling box, *a*, is inclosed in a jacket, so that it shall not come into contact with the water.

Automatic Friction Coupling.—This consists (Pl. II., Fig. 11) of a core, *a*, keyed upon the shaft, but capable of sliding, and of a conical box, *b*, loose on the shaft. This core is thrust by a spring which bears against a nut, *c*, which screws upon a ring, *d*, fixed firmly to the shaft. This ring is designed to give the spring the necessary compression to make it operate. This result is obtained by screwing the nut, *c*, upon the ring, *d*, by means of a key. The keys of the core, *a*, have a peculiar form. They are provided with a shoulder, PP', that enters a depression in the center of the wheel, and they pass through the ring, *d*, and are controlled by the sleeve, *e*. This latter is provided at its upper part, *v*, with two recesses into which enter the heads of the keys. It likewise carries two clicks, OO', which, passing into the ring, *n*, gear with the ring, *h*, when the lever, K, is moved.

When it is desired to set the machinery moving, the lever, K, is maneuvered. This disengages the clicks, OO', through the pressure of the hand upon the secondary handle, *r*, which, bearing through the ring, *r*, against the heels, SS', of the clicks, OO', lifts these latter, and disengages them. The cone, *a*, thrust by the compressed spring through the ring, *c*, can then come into contact with the box, *b*, as gently as may be desired, by a maneuver of the lever, K. In order to throw the mechanism out of gear, it is only necessary to pull the sleeve, *e*, back by means of the lever, K, and thus disengage the cone, *a*.

Through this combination, the starting or stopping of the engine is always effected by a given pressure, without any thrust upon the shafts, since no external bearing point exists.

Use of Oars.—This mode of propulsion is utilized in case of damage to the motor. Figs. 6 and 7 (Plate II.) show the arrangement adopted. The oar is divided into two distinct parts. The lever handle, *a*, is connected with the shank, *b*, of the oar by an axle, *c*, which passes through a bronze piece, *d*, fixed by bolts to the sides of the boat.

The blade, properly so called, consists of movable paddles, which bear against one another at the moment of the purchase upon the water, and which separate when the oar is moving back again to its starting point.

Maneuver of the Boat.—The officer and his assistant having entered the boat through the manhole, the latter is closed by a dome, *a*, fixed to the top by hinges and a bolt with screw and thumb-nut. The lower part of this dome enters a rubber-lined groove, so that no water can infilter. There are seven apertures in the dome, one in front, one behind, two on each side, and one above. Each of these is closed by glass nearly half an inch thick, and is protected by a grating that in no wise interferes with the view. In case a glass gets broken, the window is closed by a cap provided for the purpose. When the boat is not submerged, these windows may be open.

Toward the stern of the boat is placed a torpedo containing one hundred and ten pounds of dynamite or forcite. The size of this depends upon whether it is to rise toward the surface or be sunk. It is held by a click or bayonet catch, from which it may be freed from the interior of the boat, and is connected with a wire that winds around a drum situated behind the dome. This wire connects with a commutator in the boat. The torpedo may have almost any form.

In the interior of the boat are the compressed air reservoir, *b*, serving as a seat, the mechanism for running the boat—pedals, oars, and electric or compressed air motor, the water pump, *c*, the air pump, *d*, for expelling foul air, the double-acting pump, V, for preserving stability, and the various levers, cocks, and gauges, telephone, compass, etc.

The subaltern, who is seated behind his officer, in obedience to the latter, opens the cock, *e*, in order to allow compressed air to enter the boat. This cock is actuated by means of an endless screw. The air first passes into the water reservoirs, *h h'*, through the pipe, J, in order that it may become moistened, and then enters the dome, *a*, through the pipe, K. The gauge, *l*, constantly shows the pressure of the air in the reservoir, *b*. The air pump, *d*, is set in motion, in order to expel their foul air. The sailor starts the boat on the float line shown in Fig. 1 (Plate I.). The boat is maneuvered *in situ*, backward, forward, and in all directions, at the command of the officer, by means of the hand wheel, *m*, which shifts the movable helix, and of the lever, *u*, which reverses the machinery.

When a vessel is to be attacked, the officer directs the sailor what maneuvers to perform in order to place the vessel and the sight, *n*, in line. This done, he casts a glance at the compass, O, observes the position of the needle, and then opens the three-way cock, *p*. This latter allows water to run into either the reservoir, *h* or *h'*, or into both. At the desired depth (shown by the pressure gauge, *s*), he closes the cock, *p*, and moves with certainty toward the vessel through the indications of the compass, the sailor steering the boat according to orders. When the officer perceives that he is under the ship, through the window in the top of the dome, he directs the necessary evolution to be made to obtain a proper position. When this is obtained he unfastens the torpedo, and this, rising toward the surface, fixes itself to the ship's bottom, by its ascensional force and the metallic points that extend around its circumference. This done, the boat takes its departure. The wire, upon unwinding from the drum, shows the sailor, and consequently the officer, just what distance the boat is from the enemy's ship. At a distance of from 300 to 450 yards the officer establishes a contact by means of the commutator, and thus causes an explosion of the torpedo. This done, he comes to the surface by expelling the water from the reservoirs, *h h'*, and regains the shore or the vessel to which he belongs.

The boat is provided at the bow with a cutter bar which may be shoved out to a distance of ten feet, which is capable of moving in all directions, and which is lighted by an electric lamp. By means of this bar and the lever, *t*, torpedo wires placed in the outer port may be divided.

The torpedo boat shown in Plate I. is 16 ft. in length, 5¾ ft. in height, and 3¼ ft. in width. Its total displacement is 63½ cubic ft., and, when the water reservoirs are empty, 56½ cubic ft. The capacity of the water reservoirs is 10¼ cubic ft. The safety weight weighs 660 pounds, and the gross weight of the boat is 3,190 pounds.—*Annales Industrielles.*

SCIENTIFIC METHOD IN MECHANICAL ENGINEERING.*

By COLEMAN SELLERS, Professor of Mechanics, Franklin Institute.

I PROPOSE, this evening, saying a few words to you on the part that systematic, scientific method should play in the most ordinary mechanical occupations, and to point out the need of orderly method in the advancement of all the arts. I had occasion, the other day, to watch the operation of a mechanical shoe-maker, at work in the Novelties Exhibition. Boots and shoes were being sewed on this machine, the stitches made with brass wire; brass staples were selected, automatically, of the proper length, and were inserted in place. My attention had been critically drawn to this machine in acting as judge in the class to which it belonged; not very far away were books, which, in binding, were sewed with wire staples, and between the two were many devices to enable hand-sewing with wire staples to be done with ease. My mind naturally grouped these objects and processes, and even flew back over many, many years to days of childhood, when I had learned one of my first lessons in mechanics from my father, who held me in his arms, so small was I, as he showed me the then great wonder of fine steel wire bent in a machine into staples and driven through thick leather in rapid succession, to form the fine teeth of the cards used in carding wool and cotton fiber. I was not at, say, five years old, too young to remember the lesson when it was facts that were given me to think over. He took good care to point out that the fine wire forming the staple could be driven through the leather with precision, and without any holes having been pierced for it by more rigid needles, or through holes no larger than the wire forming the staples. The card clothing machines at Cardington were driven by water power, but this mechanical shoe-maker at the Novelties was driven by a steam engine of the highest type. That steam engine had its lesson to teach; a life, too, could span much of the period of transition from the first crude machines that grew out of Oliver Evans' notion of a high pressure engine to the work of Corliss and others of to-day. It had made but little advance, even as early as I can remember, as compared to the results of to-day, and its slow growth had been after the manner of the survival of the fittest. Its history is cumbered with a vast amount of negative information, by years of mistakes, the result of empirical methods as against the systematic mode of more modern research. As the steam engine grew toward its present state of perfection in spite of the many drawbacks, the theory of thermo-dynamics took shape.

The practical mechanic who prides himself on the grand fact that he has drawn all his information, as it were, through the handle of the hammer he has worked with, has a holy horror of all that savors of science, and, what is more, he holds in contempt the scientific engineer. It was one of these practical men who presented a contrivance of his to a railroad company for trial; some of the directors thought it would be well to investigate, and the trial was made. The inventor after said that the failure was due to the scientific experts who conducted the trial. He suspected they had put some thermo-dynamics or some other scientific stuff into the boiler, on purpose to prevent his device from

* From a lecture delivered before the Franklin Institute, November 4, 1885.

operating. Now, thermo-dynamics is the name given to the science that takes into consideration the correlation between heat and work. The designers of the great engines of to-day have the advantage of a pretty thorough knowledge of the laws that have been found to govern the conversion of heat into motion and of motion into heat. Could a knowledge of thermo-dynamics have preceded the steam engine, there is no telling how much farther we would have been now in our motive power department of the world's industries.

We are living in an age when the Baconian inductive system of research is relied on; the rapid progress of modern times is due to the results of the inductive system. In old times, the philosophers contrived theories to account for known facts. Lord Bacon was the one who clearly pointed out the need of obtaining many facts, and finding the laws that govern matter through and by the study of the facts, but going beyond the range of the facts that we can obtain for the purpose of investigation.

The old philosopher stood on a hill, and saw the land spread out before him as a mighty plain; and as he watched the movements of the heavenly bodies, he saw them rise in the east and sink below the horizon in the west. Upon this visible fact, he concluded, with the more modern colored preacher in Virginia, that "the sun do move," because he saw it move, and so from this visible fact he proceeded to build up a theory of astronomy, and hunted for other facts to sustain this theory.

A more modern inductive philosopher, under the same conditions perhaps, notices that objects floating on the surface of the sea sink out of sight at the horizon; and as these bodies are moving, hence infers that the surface of the world is round, and, gathering many more facts, he then draws conclusions from his observation that enable him to look farther ahead, and foretell, as it were, greater discoveries.

The wonderful progress of modern times is due wholly to the method that has been pursued of grouping facts in proper order, working out laws that govern matter, and proving that the laws are correct by finding no exception to them. An established law is what explains all phenomena bearing on it, and when no known fact offers any contradiction to it. Established laws are many, and the knowledge of these laws makes the wisdom of the modern scientific mechanic. There are laws that can be so thoroughly trusted that we no longer need investigate, and we follow them with confidence, knowing that we cannot change them, if we would do so. Gradually the knowledge of the world has become formulated, and we have in simple form ready for work the accumulated knowledge of all who have preceded us. We have before us, it is true, a vast field of experimental research, but we are in the position to guide our work systematically by the lights we now have. The day for empiricism in mechanics has gone by, and I wish to show you this with a few simple illustrations.

I have here a ball, attached to the end of a piece of string. The string seems strong enough to carry the ball; at least, it does not break under the strain. I whirl the ball in a circle, and past experience leads me to infer that if I whirl it rapidly enough the string will break under a strain, due to the centrifugal force incident to the rotation. This fact is so well known to all of you that it is not needful for me to prove it by trial. We hear of flywheels and grindstones breaking when revolved too rapidly. If, for any reason, I should desire to keep up the rotation of the ball at the end of the string with safety, I must know the force exerted on the string during rotation, and I must know the ultimate strength of the string. I have only to know the weight of the ball and its velocity in feet per second during rotation, and calculation will give me the strain on the string more accurately than I could obtain it by experiment. Now, on the other hand, no amount of calculation will tell me if this particular string is strong enough to bear the strain with safety. To find out the ultimate or breaking strength of the string, I must load it with an increasing weight until rupture takes place; and the information thus obtained can be used with some degree of certainty with the balance of the twine on the ball from which was taken, or can be used to predicate the strength of another string of similar size and construction. This homely illustration will convey to your minds what I want to make clear, namely, just where we can rely on calculation, and where experiment must be resorted to continually.

Let me now give you an example of the working of the scientific method in actual practice, covering a case involving calculations and experiment. Steam boilers have been made to serve the purpose of death traps from the most culpable neglect of ordinary precautions for safety, coupled with gross ignorance of Nature's laws, until the authorities were obliged to step in and define by law certain precautions that must be taken for the welfare of the community. Steam boilers are made of sheets of iron or steel bent into shape and joined by rivets. As the strength of the entire structure is limited to the strength of the weakest individual part of the structure, it is of moment that the true value of any particular kind of riveted seam be known by actual experiment. There is no way of making the riveted seam as strong as the body of the metal. It is now usual to so proportion the number and size of the rivets to the thickness of the plates to be joined that the metal remaining between the rivet holes shall about equal the strength of the rivets that unite them. In determining the pressure of steam a boiler already made can be permitted to work under, a calculation is gone into as to the strength of the seam, as measured by the area in section of metal between the rivets, and also measured by the size and number of the rivets, and the strength of the seam is assumed to be the lowest result of the calculation. After this, it may be necessary to know the strength of metal that forms the boiler, and just here is where the lesson of the ball and the string comes into play, and our present illustration is as readily understood. It does not require a very high order of talent to master the calculations that are resorted to, to determine what strain will come on this or that part of the boiler, and we have to rely wholly on calculation for that information. The boiler must be made much stronger than its ultimate or breaking strength of the metal, to insure its safety in use, and to allow for deterioration. The difference between the ultimate or breaking strength and the strain that it is to be subjected to in practice, is regulated by what is termed the factor of safety. All well considered specifications for structural metal work, for instance, call for the material to come up to some established standard of ultimate or breaking strength, and the amount of metal to be used in the structure is determined by a factor of safety specified. This factor of safety may be as low as four in some cases of boiler and bridge construction, when the known character of the material used warrants the course, or it may be as high as thirty in the case of matter subjected to shock or blows, as in the case of rapidly revolving gear wheels. That is to say, it may be considered safe to strain the structure to one-fourth of what would cause it to break, or the case may require that we dare not strain it beyond one-thirtieth of its breaking strength. The question now presents itself, how can every sheet of iron or steel to be used in the construction of a boiler, for instance, be tested, when such sheets are usually ordered from the mill of the exact size that is required, and to test a part of such sheet would destroy it for use? This furnishes me with a suitable example of the scientific method carried out with ease and certainty in every-day practice.

Steam boilers of locomotives are worked at a rather high pressure, say 120 or 130 pounds to the square inch, and the metal now mostly used in their construction is steel of a low grade as regards hardness, that is, steel of considerable ductility. From the specification for boiler and fire-box steel issued by the General Superintendent of Motive Power of the Pennsylvania Railroad, December 1, 1882, I extract the following:

1. A careful examination will be made of every sheet, and none will be received that show mechanical defects.

2. A test strip from each sheet, taken lengthwise of the sheet, and without annealing, should have a tensile strength of 55,000 pounds per square inch, and elongation of thirty per cent. in section originally two inches long.

3. Sheets will not be accepted if the test shows a tensile strength less than 50,000 pounds or greater than 65,000 pounds per square inch, nor if the elongation falls below twenty-five per cent.

4. Should any sheets develop defects in working, they will be rejected.

5. Manufacturers must send one strip for each sheet (this strip must accompany the sheet in every case); both the sheet and strip being properly stamped with the marks designated by this company, and also lettered with white lead to facilitate matching.

Now let me explain this specification to you, as it has been explained to me in the admirable test room of the shops at Altoona:

There are many makers of steel boiler plate in the United States, and without referring by name to any one, I can state that the Pennsylvania Railroad has decided on a set of arbitrary signs to indicate each maker. One is designated by a triangular stamp, one other by a circular stamp that marks a ring of about one inch in diameter, another by a square of like size, and so on. Sheets of steel come from the rolls with a more or less irregular outline and of a size that will permit the test strip to be cut off from one or the other edge without difficulty. The plate in the rough is, when cold, scribed to the required size of sheet that it is to be sheared to, and on the other shear line two marks are made by the prescribed stamp, one mark being made at one blow of the hammer and the other by the same punch or stamp at another blow, and at any convenient distance from the other, but in no case are the two marks made by a twin set of punches or stamps at any fixed distance one from the other. This irregularity of the stamping renders the after matching of the strip, or coupon as it is called, an easy matter, with the sheet from which it has been cut, the shear cut being made directly through the marks. The matching is still further facilitated by numbers or signs in white lead.

After reception by the proper inspectors on the road, the samples, or coupons, are stamped with corresponding numbers after verification, and the test piece goes into the shop to be dressed to the proper width for the test, and the sample is then broken in a testing machine, and, in a book kept for that purpose, entry is made of every particular connected with the test, and the sheet received or rejected on this record. Suppose, however, that a sample shows a higher tensile strength than the maximum allowed, namely, 65,000 pounds per square inch, and that such specimen has an elongation or ductility as great as can be desired, it may be well asked why it should be rejected. In the book of record, I have seen some such cases, and reference is there made to the book of the chemist, into whose hands such sample is sure to go. His chemical test had in all cases, up to the time I saw the book, indicated too much carbon in the steel; and a simple physical test of heating and plunging the hot steel into cold water has shown it to be capable of being hardened. It is not deemed wise to employ any metal that has hardening qualities in the construction of steam boilers. After many such trials, the officers of the road have come to consider the tensile and ductility test as final, and as expressive of the qualities wanted. Thus, you see every sheet in every boiler has its physical quality when new recorded, and its marks enable its after history to be noted. No sheet of steel can meet with mishap afterward without having the report of the mishap recorded on the page that marked its acceptance, and its life or durability also noted. Such, in brief, is the account of the admirable scientific investigation into the quality of the material used in boilers, as reduced to practice, and so persistently pursued by this one company as to be now no longer a subject of comment. This method of test, however, is the outgrowth of systems that preceded it. Practice and theory must agree. The scientific engineer can lay claim to the title only when he is abundantly fortified by sound experience, and has learned to view all things evenly.

In the specification of the Pennsylvania Railroad, as already cited, stress is laid on the percentage of stretch before rupture takes place in the required test. The date of the printed specification I have referred to is 1882. On January 8, 1881, I had a letter from the General Superintendent of Motive Power, in which he describes other tests which had been used for a long time. These were bending tests:

1. Bending cold.—A strip from each sheet must stand being bent over double, and being hammered down flat upon itself without fracture.

2. Bending after being heated and dipped.—A strip from each sheet must stand being bent ver double, and being hammered down flat upon itself, after having been heated to a flanging heat and dipped into cold water, without sign of fracture.

He informed me that the bending tests had been insisted on for several years, but that the certainty of the ductility test had caused them to make it the final mode of determining the quality of the steel submitted to them. In order to make the bending as uniform as possible, they adopted the plan of holding the strip to be bent between rigid jaws and striking the projecting end with a ten-pound sledge until it is deflected about 135°, when it was removed from the jaws and held with tongs while it was hammered down flat on an anvil. The bending after heating and dipping was added to protect them against acceptance of hard sheets, by reason of the test strips being annealed, accidentally or otherwise, by the manufacturers. He said that for some time past they had been testing tensilely, to obtain ultimate strength and ductility, a piece from the strip sent with each sheet, and had established a tensile test which supplanted the bending test, but covered the same ground that it did. This was done on account of the greater regularity and uniformity of the results in tensile test, and because by it they obtain figures to show the exact quality of the steel; so that even in 1881 they were working under the specification I have already mentioned as furnished me in 1882. Time is an important element in tests, particularly so in bending tests. An expert giving testimony in a trial in which the reliability of the steam engine indicator was in question, said, "I believe in the result of the use of the indicator when I know who works the instrument." The bending test is good when you see it done in a proper manner, or know who does the bending.

Hurry the bending of good metal, and it may break. Proceed with the bending of poor metal, with caution, let it rest a bit between each blow, and a skillful man can bend a strip of brittle steel so that the specimen will deceive the most expert. It is a very curious property of wrought iron and steel that, after being strained above the limit of elasticity and near to the point of fracture, rest will restore their strength. The story is told of some tests being made on beams for structural work before some officers of the Government. One maker strained a beam up to a point near to the breaking point, and then invited the Board to test some champagne, saying that he was willing to let the beam remain under its heavy load until after lunch. When the test was resumed, a strength was shown that could not have been reached had the rupture been hurried to completion, and the metal had been allowed no time to accommodate itself to the strained condition.

Let me now go back to the consideration of material used in boilers. During the latter part of Mayor Stokley's administration, say about 1880, he, at the instance of the City Inspector of Steam Engines and Stationary Boilers, and of the officers of an insurance company for inspection and insurance of steam boilers, appointed a commission to devise some fixed rules, whereby uniformity of rating could be insured as to the pressures at which boilers may be worked. I had the honor of serving on that commission, and am thus enabled to tell you that we found a set of rules in force which gave to all boilers of the same diameter and the same thickness of metal the same pressure per square inch, regardless of the quality of the metal employed in construction and of the nature of the riveted seams. Fortunately, however, our City Inspectors of Steam Boilers were practical boiler-makers, and were familiar with the requirements, and could refuse to pass boilers manifestly unfit for use; for men long familiar with work of this kind come to learn what is right by experience and good common sense. The ordinances passed by Councils, at the suggestion of the Commission, made it imperative that all the conditions that exist in each boiler as to nature of seams, thickness and quality of the metal used, should be considered, and the boilers rated accordingly, giving the greater latitude to good workmanship and good quality of material combined with judicious proportioning of the parts. At the time to which I allude, but a few years ago, the United States laws in regard to the testing of boilers used in the marine service called only for a knowledge of the tensile strength, and no notice was taken of the softness or ductility of the metal combined with great strength. I know a case in which a sheet had to be selected of higher tensile strength than could be obtained at the time, coupled with much ductility, to repair a boiler so that it would pass the Inspectors under United States laws. A lower ultimate tensile strength with high ductility would have made a safer job of the repair. We have come to the time now when, to hold our place in the world in competition with others, we should waste as little of our energies as possible in cutting and trying in any haphazard way, and endeavor to avail ourselves of the acquired knowledge of the world generally, and make scientific application of the knowledge in our daily work.

We find it to our advantage to utilize the talent that comes from the technical schools, only guiding and holding in check the schoolmen until they have learned the lesson of the workshop practice. You must bear in mind that it has been asserted that the Puritan, the Genesta, and the Pilgrim were all designed by men who had a theoretical knowledge of boat building, and were not practical builders. The talent shown by the theorist who did save the cup for America in an international contest might be utilized to advantage in the workshops of the practical boat builder. On the other hand, the record of failures and mistakes for the want of practical experience or sufficiently extended knowledge in the endeavors of newly fledged scientific experts are many and lamentable, as all know who are obliged to utilize their talents. Scientific men, too, have been charged, often wrongfully, with retarding progress. Dr. Lardner is accused of having stated, in his early lectures delivered in America, that the ocean could not be successfully navigated by steam, mainly on account of the large quantity of coal required as compared with the carrying capacity of the vessel. It was in 1840 that he lectured here, and he remained in America until 1849. The Sirius and the Great Western steamships arrived in New York on St. George's day, April 23, 1838. Dr. Lardner's comments were made in England, at Bristol, August 25, 1837, before the Mechanical Section of the British Association. His opinion was asked, and was published in the *Times*, August 27, 1837. He never expressed a doubt as to the practicability, as has been stated. The substance of what he

then said was that the marine engine, with its then state of efficiency, was not able to cross the Atlantic from England to New York profitably without the patronage of Government. The engines of his day burned eight pounds or more of coal for every hourly horse-power developed, while we can do the same work with two pounds of coal per horse power, and we desire Government subsidy to keep our ships afloat.* Since the time that the great Western steamed into New York Harbor, what changes have been made in steam engines and in marine architecture! When in Scotland last year, I visited some of the noted shipyards on the Clyde. In the yards of the Dennys, at Dumbarton, I was present at the trial of a model in the testing tank to determine the wave line on the side of the ship. Certain side-wheel steamers were to be built, and it was advisable that the wave line on the side of the ship, incident to the motion of the vessel, should be so fixed as to have the crest of a wave rise with certainty just where the paddle-wheel struck the water, and not compel the blade to reach down in the valley of the water for its hold in driving the ship forward. Theory had given a shape to produce this wave line, and a model ship, about eight feet long, cast in paraffine, and worked up to the required lines on an expanse profiling or sculpturing machine, was being tested, and record made of all the conditions that could be noted by trained experts. In the same building there were employed, I should think, at least twenty men and women, doing the clerical work of the calculations involved in scientific ship-building.

In London, last year, I was present in the lecture room of the Royal Institution, on Albemarle Street, in the room made celebrated by the exposition of the discoveries of Thomas Young, of Humphry Davy, of Michael Faraday, while each in turn presided over that institution, and gave to the world, in that room, the result of their close scrutiny into the working of the laws that govern matter. The lecturer of the evening was treating of the motion of fluids, and one of his experiments was so striking that I venture to repeat it now, as it shows how much deeper we must go than the surface of what we see in search for exact truth. He produced a cubical block of wood, such as I now hold in my hand, suspended by a string attached to the center of one of its faces. See, the block hangs like any other piece of inert matter, with its center of gravity in line with the axis of the string. We see nothing unusual in the behavior of the block. If I try to make it hang in any other position, the force that placed it in position being removed, it falls back to its normal position. If I attempt to make the block stand on one of its edges, it falls over, and we know, after a few trials, that such position is one of unstable equilibrium, and not to be relied on as permanent. I have here, however, a block, also of wood, of the same size and shape as the first one. It, too, is attached to a string; to all appearance, it is a similar block. I hold it in such a position that the string is dependent from one of the vertical faces of the block, and not from the upper one. I hold the string and release the block, and it does not fall from this constrained position, but seems to hang to one side of the string, in what, to our senses, seems an abnormal position. I stand it on one edge, and it does not fall, as did the first block. I might place it in other positions, and the effect would be as striking. Now, what makes one bit of wood act as we are accustomed to see matter act, and the other to act so differently? I will tell you: The first block was what it seemed to be; the second has motion inside of it, and that motion, under certain well-known laws, controlled the position of the block. See, I open the second block, which is hollow, and in the box is a brass top, which has been and is yet spinning. The forces concerned in the rotation of the top were powerful enough to control the light form that simulated the block of wood.† The learned lecturer in London used this simple experiment to show what motion will do, and it was one of many experiments in the direction of showing the difficulties that attended the study of the motion of fluids, when motion within the fluid, not visible to the human eye, was exerting a controlling influence, and leading the mind of the observer away from the true facts of the case. I venture to show you this as illustrating the care that must be observed in seeking for truth. It requires a trained mind to follow the most direct road in any complicated investigation into the laws that govern matter, and the same training is needed by every mechanic in the orderly and systematic carrying out of his designs.

I have spoken of the inductive system of investigating the laws of the universe as practiced now. Modern scientific advancement is measured by our knowledge of the laws that govern matter, and its progress is in proportion to the abandonment of empirical methods. All knowledge is based on the observation of facts. If we attempt to draw conclusions from too few facts, we may not be wrong in our conclusions when we have to deal with cases involving the same facts, but we may err greatly when our formulated method is carried in practice far beyond the experiments upon which it was based in the first case. I will mention a noticeable example: We are probably indebted to no one more than Morin for his experiments on friction.

No one has been able to controvert what he discovered in regard to the laws of friction, but cases occur in which there seems to be manifest disagreement with his laws, and these cases are always outside of the scope of his series of experiments. In other words, he did not carry his experiments far enough in the direction of velocity and in the direction of pressure, nor do we yet know all the conditions that obtain in the friction of different substances as we approach their destructive limit in use. As we extend our knowledge by still further experiments, we do not find any flaw in his expressed laws, so far as his light went; but we introduce other factors in the equation, factors that were of no moment in the experiments he tried, but which become the prime factors in the more severe requirements of application far beyond his in both directions. We are as yet, with all our information, but on the threshold of knowledge, but we are growing to be sure of one thing—that we have passed the time of empiricism, and to advance profitably we must pursue systematic rules of progress. In the competition of the world, we cannot afford to make mistakes; while to avoid mistakes, we must decide just what we want to do—the character of the material we have to use as well as the forces involved in the operation to be performed. We are to have a new bridge over the Schuylkill at Market Street some time. We are wise enough to know that it will not do to have that structure built by rule of thumb, trusting to rebuild it in a better manner later. It is doing things wrong once, twice, and often many times before we stumble on what will barely serve our purpose that is costing so much money and giving so little satisfaction and retarding progress. We cannot walk a square on any of our cobble-paved streets, which should serve the purpose of facilitating the traffic over the roadbed, but we wonder at the want of knowledge shown by those who regulate our municipal matters, and have permitted, and still permit, such structures to remain, at a constant cost in detriment to the property hauled over them and the discomfort of ourselves. Street railways in many cases have their tracks perched on the center of a narrow street, with so much curve or camber to the pavement that the railbed is as high or higher than the curbstones on either side, and the slanting pavement on either side of the track is on such an incline, and so roughly paved with huge round stones, as to set at defiance all the laws of mechanics, that dictate a road of the least resistance as the most economical, both in wear and tear to the road itself and to the conveyances that pass over it. The locomotive proposed by Oliver Evans in the beginning of this century was to have run on the country roads, but he, with his limited knowledge, even hinted at special roads made to offer less resistance. Our streets are paved to make the most resistance. The locomotive was useless until it found a road adapted to its purpose. The success of the locomotive depended on the condition of the road it traveled on. Great results followed in practice when a scientifically constructed and well-laid road was ready for the locomotive. Let us have smooth, well-laid streets, too.

Cable railroads have been in use in many cities for some years. Their construction was experimental, and their present economy is problematical. I am not prepared to say just how scientifically they have been constructed in Chicago and the far West, but here in our own city we are seeing a gigantic constructive experiment tried on the cut and try principle. Metallic conduits for the traction cable are put into place over miles of roads, the conduits being so formed as to have little or no power of resistance against the crush of the frozen ground, and even so made as to present a shape most favorable to permitting the pavement to wedge the grip slot shut. Wheels are put in to guide the ropes, seemingly without any regard to strains that might have been known beforehand, or, if not known, should have been found out by careful experiment; and the citizens, who should be using the streets to their best profit and convenience, are kept off them by a constant succession of changes, involving tearing up, altering, replacing, to the discomfort of our fellow-citizens and to the loss of the company owning the road. The public are less interested if this cut and try system is taking place in the private workshops, and the public cares very little about the stages of progress through which any finished product has passed in reaching the stage of use to the consumer. The public are warranted, however, in objecting to unsystematic and ill-advised engineering enterprises being conducted to their detriment and delay. There will be no end, however, to just such empirical engineering. The desire to save in the first cost, without considering the after result of such false economy, will be the rule perhaps for a longer time in the future than any one here is interested in; but it is the outgrowth of much evil in the methods of our schools. One of the first objects of education is, I think, to quicken the perception, to teach the habit of observing phenomena clearly and quickly, to instill the desire to trace effects to their causes, and to cultivate close and just reflection. The elements of geometry, physics, and mechanics should have the preference over many of the traditional studies of the primary and the grammar schools, and what is more, the early introduction of such studies, presented to a child's mind in a practical form, as they can be, will prepare his mind for the more extended study of the higher branches of the same subjects in later years. As it is, the alphabet of science is not taught until the student is ready to read the subject in later life, when he should have grown up with a feeling that he always was in a measure familiar with the facts of science.

General Francis A. Walker, President of the Massachusetts Institute of Technology, in a paper read before the American Social Science Association, September 9, 1884, said, in speaking on this subject: "Do you ask me how much of the elements of physics and mechanics should be given to a child of tender years? I answer, just as much as he will take, be the same more or less. And it is always safe to offer him more than he will take. It can't do him any harm. Cramming him with hard and lumpy facts, from so-called geographies or histories, may produce mental indigestion or colic; but an idea, an apprehended principle, never yet hurt a human being, and never will to the last syllable of recorded time. For myself, I would not stop teaching a child the doctrine of the persistence of force through all transmutations. Doubtless he would at first fail to apprehend it fully; yet he would gather something from its familiar, picturesque enunciation; and as the proposition became familiar to his ear, and as illustrations of the equivalency of motion, heat, light, and sound were multiplied and repeated to him, I should hope that he would grow into an apprehension and appreciation of this grand, all-embracing law."

He also said that a child often of twelve years is capable of understanding the principle of the lever just as well, or as perfectly, as did Archimedes of old Syracuse; and that if the conception is once implanted in the mind, it will become germinal, and will, with without watering and tending, but bear fruit perennially through his life.

With a higher education in the direction just briefly indicated, the people will more generally come to understand the need of avoiding all empirical practice in the exact sciences, and learn the truth that all mechanical processes, all constructive work, in fact, all that goes to make up the sum and substance of our surroundings, are governed by exact laws, which, if not observed, bring their own punishment for neglect.

* See New York *Times*, January 8, 1881, letter of W. W. Evans.

† The apparatus used consisted of two cubical blocks, each six inches by six inches by six inches—one solid, the other formed of wood three-sixteenths of an inch thick; and in this box was a well-made gyroscope in a metal ring, loaned for the occasion by Messrs. Queen & Co., of this city. The attachment of the suspending cord was at the center of the face of the block, close to one end of the axle of the gyroscope.

DAVIES' SYSTEM OF RAILWAY RAIL-FASTENING.

GEN. THOMAS A. DAVIES, of New York City, is the inventor of an improved system of railway rail-fastening, which is herewith illustrated and described. The system consists of a new fish-plate and fulcrum spring, or its equivalent spring-washer, making, as claimed, a permanent elastic joint; two new forms of spikes to be driven at an angle into the tie; a stay-plate driven back of the spike across the grain of the wood, and a center fastening for the rail, and metallic friction-plates to prevent the rail from cutting the tie. The device is protected by eight patents, and its various parts will be described separately.

Fig. 1 represents the three-bearing fish-plates; F F

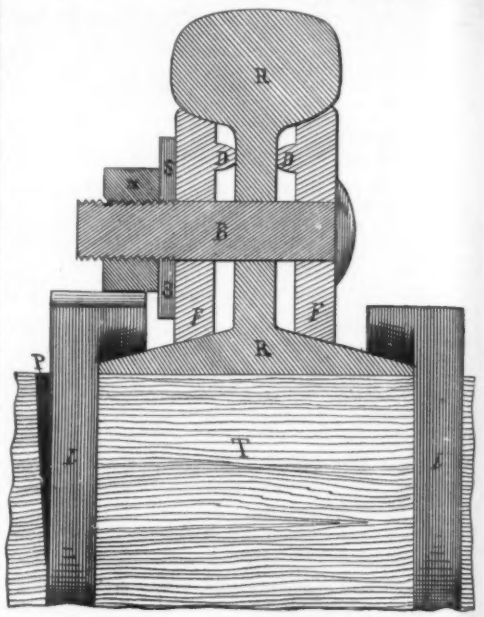


FIG. 1.

represent the cross-section of a pair of these fish-plates. They are the strap fish-plates with the usual holes for bolts, with a rib drawn upon the upper inside face to insure a firm bearing on each side of the web of the rails, and also a bearing upon the upper and lower bevels of the rails. These plates are to be drawn out to fit in this manner any sized rail. The plates with their bearings are kept continually in their places by the ordinary nuts and bolts acting upon powerful fulcrum-springs, or metallic spring-washers, as will hereafter be described. It is claimed that there will be no wear to these plates if the bearings are kept up continually, because there is nothing that can give, and hence no wear. It is the keeping up of these bearings that is the essence of the device, and makes the joint perpetual.

Fig. 2 relates to the powerful fulcrum-spring. This spring is represented in full size and shape, and it is

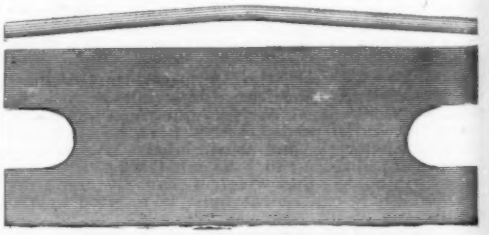


FIG. 2.

made of the best spring steel, tempered, $\frac{7}{16}$ inch thick, $2\frac{1}{4}$ inches wide, and $1\frac{1}{2}$ inches longer than the distance between the centers of the bolts over which it operates by means of slots in the ends of the spring. The two arms of the spring from the center are made straight. The spring has a recoil to each end of $\frac{3}{8}$ inch, and, as near as experiment could prove, has a recoil power equal to one ton weight on account of its shortness.

To make the joint, the fish-plates are set in at the top, and then their bottom slid on the lower bevel until the three bearings are attained. The bolts are then inserted in the usual way, and the springs are put over the bolts, the bolts protruding through the slots in the springs, with the angles of the springs resting against the fish-plate. The nuts are then screwed on, and this is continued until the ends of the springs touch the fish-plates. The bolts and fish-plates are then smartly hammered up to their bearings, and if the ends of the springs are then away from the fish-plates, the nuts are screwed up again until the ends of the springs just touch the plate. A center punch is then taken, and the point placed on the angle between the nut and the screw. It is given two or three raps of a hammer on the punch, which will destroy the continuity of the thread of the screw, but will not injure the screw. If the nut is required to be taken off, a wrench applied to the nut will recut the thread, and the screw be as good as new. The joint is then complete. In Fig. 1, F F are the fish-plates, S the springs, B the bolts, N the nuts, R the rail, and T the tie. It is claimed that there will be about two tons pressure on both plates to keep them to their bearings; while the bolts will never break unless they are defective, for they are held by the elastic springs, which will give and take to any contraction or expansion or any sudden force. It is also claimed that these plates, springs, and bolts, from

experiments made, will never wear, and will remain as they are put during the life of the rail. If, however, some wear does take place between the rail and the fish-plates, the springs will take it up, and the bearings will still be continued and maintained.

The inventor gives the following result of an experimental test of these joints, and his deductions therefrom: "These joints have been in use in the Grand Union Depot and New York Central yard for eighteen months, where the wear is estimated to be equal to twelve times the wear on the main line outside, so that they have had a wear equal to eighteen years on the main line of the New York Central, a road doing an immense traffic, second to none in the country. The joints have never been touched or repaired, nor a

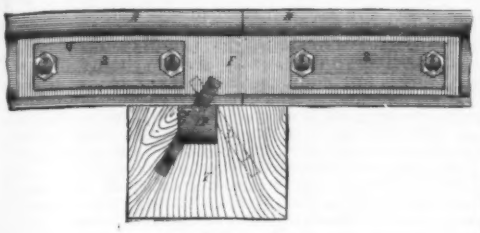


FIG. 3.

nut tightened nor a bolt broken, and they are as rigid and strong and perfect to-day as they were the day they were made, while every other joint in the yard, made with the most approved forms of fish-plates, has undergone repairs from broken bolts, or has been tightened by screwing up the nuts time and again.

"The joint has, therefore, well earned its name of the perpetual elastic joint which makes the continuous rail long sought for, but never before attained. This insures pleasant riding, and will do away with the "click-a-ti-click" so annoying to travelers, resulting from imperfect and yielding joints. To the railway investor the imperfect joint is the thief of his profits, while a perfect joint and rigidly held rail to the ties reduces all wear of track and rolling-stock to the minimum."

Another peculiarity of the device is the oblique-headed spike. To all observers it is well known that however good a bearing against the rail the common railway spike may have when it is first driven perpendicularly into the tie, it takes but a few trains over the road to draw the spikes upward slightly, and the

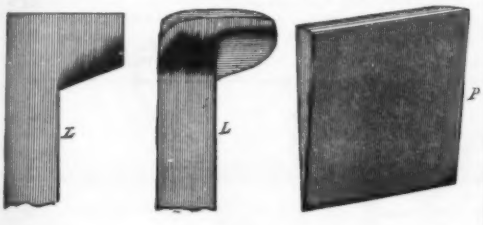


FIG. 4.

surging of the engines and cars sideways will slightly crush the wood fiber of the tie behind the spikes, sufficient to leave the rail free from the spikes. The oblique-headed spike here shown has the same body as the common spike, and the head is the same. It is made, however, with the head inclined to the body (see L, in Fig. 4); and when driven at an angle of about forty degrees from a perpendicular, the head will have the same bearing on the flange of the rail as the straight spike. This spike, it is claimed, can never be drawn from its place by any upward motion of the rail, and is strong enough to hold the tie to the rail under any circumstances.

The inventor gives the following as the defects of the old system of rail-fastenings and the benefits of the new, as substantially set forth in the patent specifications:

"The spikes may remain in place, but the rail is free to move within the end fastenings of the rail, and also to the right and left; all of which motions are at first small, but sufficient to do great mischief to the tie, and sometimes to the spike, resulting in the spreading apart of the rails, when damage and accidents ensue. These are not common on well-constructed roads; but on any road, if the spikes are loose on the inside of the rail, the rail may roll and produce the same results. In this view the spike is a very important factor in railroading, and important to be so made and driven that it cannot be drawn by any upward motion of the rail, or the fibers of the wood tie be crushed behind the spike. As soon as the spikes become even slightly loosened, the rail, as before stated, can move slightly on the wood of the tie in any direction, and the sand getting in between the tie and the rail will perform the same duty in cutting away the tie that the saw does in cutting stone when fed with sand and water. Comparatively few ties last until decay ends their usefulness; they are mostly cut out and destroyed by the ever-running rail-saw. The oblique-headed spike driven into the tie at an angle from a perpendicular of forty degrees will effectually prevent the rail from ever drawing the spike by any upward motion of the rail.

"This, however, is meeting but one phase of the trouble. The most important point is to keep the rail from moving endwise or laterally, and then get such a bearing on the tie that it will not cut, and then every difficulty is solved. The rail will then be held in place so that it can do no damage, and is safe in these respects against injury or accident. In order that the spike shall not cripple the wood fiber of the tie, a spike stay-plate has been invented; this will prevent the side motion of the rail. To prevent the end motion, the center fastening of the rail is used. To prevent the cutting of the tie by the rail, friction-plates driven into the tie under the rail are used."

Fig. 4 refers to the conical and square-head spike. This form of spike differs from the oblique-head spike in that it can be used to be driven perpendicular into the tie or at any assumed angle right or left, and still have a complete yet the same bearing upon the incline of the lower level of the rail. The lower or contact surface of the head is made in the shape of the frustum of a cone which will fit the surface of the lower bevel of the rail, no matter at what angle it may be drawn into the tie. It is claimed that it is stronger in the head for the same amount of metal used than any other form of spike made with a head to be drawn out by a spike crow-bar.

The spike stay-plate is an iron wedge about two inches square, one-quarter inch at the top and sharp at the bottom, and is represented in Fig. 1 back of the spike driven into the tie. It is also represented at P in Fig. 3, in Fig. 5, and in full at P in Fig. 4.

This plate is first driven into the tie the width of the body of the spike from the rail across the grain of the wood, then the spike is driven at an angle of about forty degrees from a perpendicular between the rail and the plate. They are intended to be used on the outside of straight tracks, one to each second tie, also on the outside of gentle curves, one to each tie, and on sharp curves, two spikes and two stay-plates to each tie. These stay-plates re-enforce the fiber of the wood so that no movement of the rail, it is claimed, can take place outward.

Fig. 5 represents the center fastening. The rail-clips are made in the rail at *c c*, the depth of the width of the body of the spike, not opposite each other, but to the right and left of the center of the ties. The stay-plates are then driven into the tie snug to the rail and opposite the clips, and left to project one-quarter inch above the ties. The clips are three-quarters of an inch long and one-half inch deep. The two spikes, either oblique-headed or conical-headed, are started into each clip, and both spikes driven at the same time at such an angle that the spikes will bind on the sides of the clips of the stay-plates when driven home to their places.

The inventor gives the following as substantially set forth in the patent specifications:

"There is an objection to clipping the flanges of the steel-rail, and, *per se*, that objection is sound where nothing is to be gained by doing so. But if there is a valuable object to be gained, and the gain is worth more than any risk of danger, it is equally sound to do it. But if it is seen that the clip which weakens the rail in fact, though practically does not injure its utility, is made up by re-enforcing its strength at the clip, then the objection falls to the ground. This arrangement of spikes and stay-plates, with the solid bearing on the tie and friction-plates in the tie, re-enforces the strength of the rail; and the rail thus re-enforced is absolutely stronger at this point than at any point not re-enforced."

The friction-plates in the tie are simply the inexpensive stay-plates driven into the tie diagonally across its grain and level with the top of the tie, as represented in Fig. 5, where the rail is broken to expose them. The rail will then have a full bearing on the wood and on the top of the stay-plates, and, it is claimed, the stay-plates will prevent any wearing of the wood of the ties.

By these devices, it is claimed, the rail will be held firmly to its place on the ties; that the rail acting as a saw will no longer do its mischief; that the perpetual elastic joint will give the continuous smooth rail, and that the new system of fastenings will save expense in

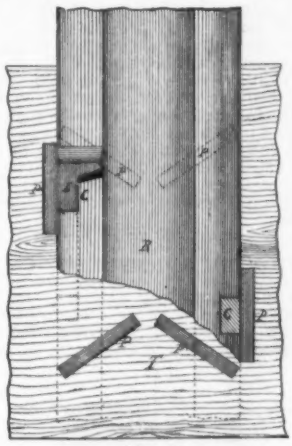


FIG. 5.

wear and tear of track and rolling-stock, equal to a small dividend on the stock of any road as against the expense of repairs of the present old system. It is also claimed that the cost of new work under the new system, including a small royalty to the patentee, will not exceed the corresponding cost under the old system. The present old system can be altered to the new by a small expense compared with the benefits to be derived therefrom.

Further information concerning the system can be obtained from Eliphalet Wood, manager of the Walter A. Wood Mowing and Reaping Machine Company, 191 Fulton Street, New York City.

H.M.S. IRRAWADDY.

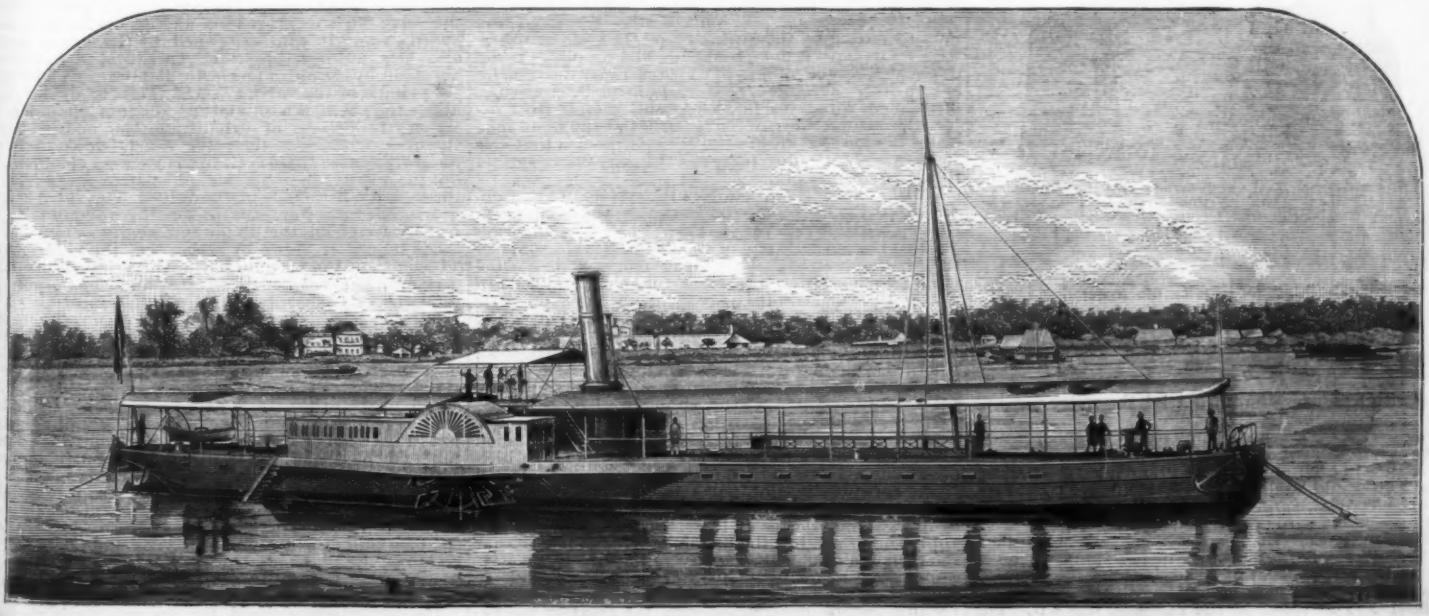
THE gunboat Irrawaddy, which we illustrate below, is of considerable interest at the present moment, as she is the principal vessel of the recent Burmese expedition, and also as she is perhaps the lightest draught gunboat in the British service. She is of the following dimensions:

HULL.	
Length, perpendiculars	200 feet.
Breadth, amidships	25 feet.
Depth	10 feet.
Draught of water at trial on Hooghly, without armament	4 feet.
Displacement	355 tons.
Speed	12 knots.

ENGINES.	
Two high-pressure cylinders	23 in. in diam.
Two low-pressure cylinders	44 inches.
Stroke	3 ft. 6 in.
Revolutions on trial	30½
Steam on trial	70 lb.
Vacuum on trial	25 in
Indicated horse power	500

BOILERS.	
Grate surface	72 sq. ft.
Tube surface	1,905 sq. ft.

The Irrawaddy, says *Engineering*, was designed and built in the Government dockyard, Calcutta, in 1876, by Josiah McGregor. She was specially constructed



H.M.S. IRRAWADDY.

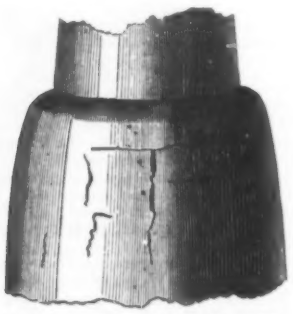
for the work she is now engaged in, and is perfectly flat on the bottom. She is provided with a water-tight deck 3 ft. 9 in. above the bottom, and the space inclosed below it is divided into a number of water-tight cells or compartments. Between this deck and the main deck, or what may be called the 'tween decks, is a clear open space extending from the engine compartment right forward and aft, and fitted with temporary cabins that can be removed when necessary.

It will be seen the vessel can thus be regarded as a water-tight tank slightly below the surface of the water, with a superstructure above it, and that to seriously damage her she would require to be injured in this lower part, to effect which a projectile would have to pass some distance through the water, and would be thus so far spent as to render it very improbable that it would pierce the plates. If, however, she were so struck below as to prevent the possibility of plugging, it would only have the effect of filling one of the small compartments above noted.

Of course, if she is pierced in the small strip which is above the cellular structure and below the water level deck, the opening could be easily plugged. Her ports offer good loop-holes for musketry fire, and with her six rifled guns on deck, and the machine guns with which she is fitted, she would have had little difficulty in repelling any attack that could have been made upon her, even if King Theebaw's valor had been equal to his discretion.

DESTRUCTION OF ORDNANCE BY GUN-COTTON

IN the last number of Royal Artillery "Proceedings" is an account of the recent destruction of guns at Alexandria by charges of gun-cotton detonated in water, by Captain Bedford, Royal Navy, communicated

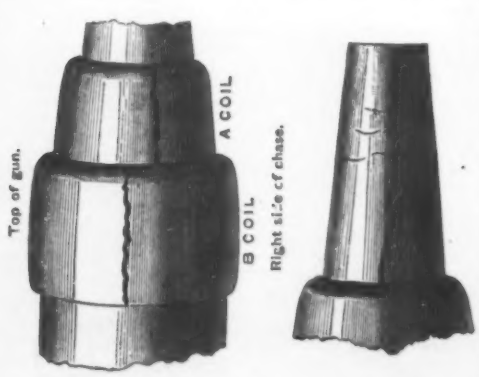


Appearance of "A" coil underneath.

by Major W. O. Smith, R.A. One example of these may be valuable as a sample. Of course, detonators fired by electricity were employed. An Armstrong 10 in., No. 2,354 of 1870, weight 39,876 lb., standing on an iron carriage on an iron platform, elevated as far as possible.

First trial.—Filled with water and a charge of 4½ lb. gun-cotton in two canisters of 2¼ lb. each, one being dry gun-cotton, the other wet. The charge was resting about the center of "A" coil. *Result.*—The coils of the chase slightly parted in places. Steel tube apparently uninjured. "A" coil opened and cracked just where the charge rested. Total length of largest crack about 9 in., breadth about ⅛ in., depth right through the coils. There was also a slight crack on the top of "B" coil, about 6 in. long. The gun and carriage recoiled on platform ½ in.

Second trial.—Gun filled with water, and a charge of 9 lb. of gun-cotton placed in line with the trunnions, 6¾ lb. wet gun-cotton and 2¼ lb. dry. *Result.*—The steel tube was badly cracked longitudinally, beginning about 3 ft. from the muzzle and running about 18 in. "A" coil was split right across, the split being quite ½ in. broad. "B" coil was also split right across, the breadth of split being slightly less. Both these were on the top of the gun. The chase was badly cracked in the right side, running about 18 in. from "A" coil. The welds of the chase coils were a good deal opened. The cracks in "A" coil caused by the first trial were unaltered. The gun was completely disabled; on being



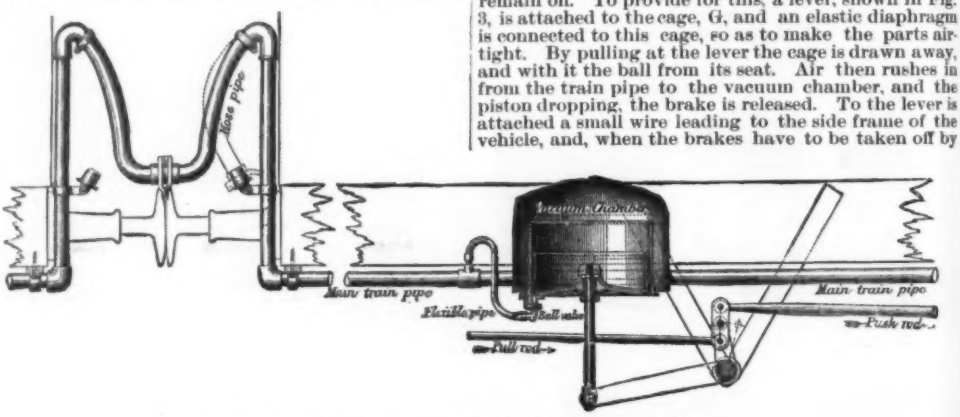
filled with water for the third trial, the water ran out from the crack in "A" coil.

Third trial.—Two charges of 9 lb. 2¼ ft. apart; lower charge on bottom of bore. Three canisters of wet and one of dry in each charge. The bore filled with water as far as it would hold, viz., to and including "B" coils. *Result.*—The chase and "A" coil with tube were blown away about 15 yards. The chase and "A" coil were broken up, but all that part of steel tube was intact. "B" coil was split and broken, merely hanging on to breech piece by a small piece at bottom. The breech piece was cracked the complete length, crack about ½ in. broad. The recoil of the carriage was 4 ft. The experiment would have been more complete had a charge been fired without water.

THE VACUUM AUTOMATIC BRAKE.

THOSE of our readers who remember the vacuum brake as first brought out by Mr. Smith will hardly have been able to recognize it in the greatly improved apparatus which was to be seen in the late Inventions Exhibition. It was there shown by the Vacuum Brake Company, of 32 Queen Victoria Street, London, and a gold medal was awarded to the company in respect of the system. It will be unnecessary for us to point out the differences between the old and the present system; moreover, they are so numerous that to specify them would occupy more space than we can devote to the subject, and would tire the reader's patience. The whole of the detail arrangements has been modified, and, in short, little else than the principle of producing the vacuum remains. These modifications have so greatly advanced the efficiency of the brake that it is stated that, as now arranged, it has the approval of the Board of Trade officials as meeting all the Board's requirements. The latest improved type of apparatus is illustrated by us in our present issue, where Figs. 1 and 2 represent respectively a side and front view of the firebox of a locomotive engine, with the cab and footplate and fittings complete, as was shown at the late exhibition. It will be seen that any one on the footplate can operate the one handle which controls the whole brake for starting, stopping, or graduating the pressure of the brake blocks on inclines. It will also be seen that the whole of this fixing of the ejector is made by one flange into the firebox front.

As regards the general principle of the automatic vacuum brake, it is to be observed that a cylinder in which is a piston is fixed under the engine, the tender, and each carriage. A vacuum is established both above and below the piston, which then, being in equilibrium, remains at the bottom of the cylinder, the brakes being off. To apply the brake, the vacuum below the piston is destroyed, when the pressure of the air immediately puts the brake on. It follows that the brake is perfectly automatic, for in case a pipe should break or any other accident happen, the vacuum will be destroyed, and the brake put on. The guard can apply it at any moment by opening a valve, which destroys the vacuum. The general arrangement of a carriage fitted with the brake, and having a guard's compartment at the end, is shown in Figs. 9 and 10 on next page, the hand brake and the vacuum gauge being



THE VACUUM AUTOMATIC BRAKE.

also seen. A tube called the train pipe is carried from one end of the train to the other; this pipe is coupled between the coaches by two lengths of India-rubber and canvas hose lined with coiled wire to prevent collapse; an enlarged view of the coupling is shown in Fig. 6. Two India-rubber rings are let into the malleable cast-iron mouthpieces of the tubes. These being brought into contact when the pipes are coupled up, make an air-tight joint. The mouthpieces are provided with a pair of lugs and two horns, which interlock and hold the pipes together. We understand that this coupling was unanimously decided upon at a meeting of railway engineers held at Euston station on April 2, 1881.

One of its most obvious advantages is that it cannot possibly be coupled together wrongly, as the surfaces would not meet unless the horns of each coupling were properly placed in position. If the couplings are forcibly parted by the severance of the train or otherwise, no damage is done to them. The couplings being duplicates, can be connected whichever way the vehicles are turned. The hose used with them is, as already mentioned, wired inside to prevent collapse from external pressure; the external pressure at the same time keeps the joints perfectly tight. It is claimed that this is an advantage not possessed by any other system than the vacuum brake.

Turning next to the details of the system, we may observe that the train pipe commences on the engine with the combination ejector, A, Figs. 1 and 2, and terminates at the opposite end of the train, the open end of the hose connected with it being mounted on a fixed plug attached to each carriage for that purpose. In Fig. 2, five vertical pipes are seen; but four of these have nothing to do with the brake, being feed pipes. Steam is taken into the ejector by the inverted J pipe, B. This ejector is clearly seen at Fig. 8, which is an enlarged section of it. The steam and air rush out in the direction of the arrow, through a pipe shown by dotted lines in Fig. 1, to the chimney. The combination ejector is the invention of Messrs. Gresham & Craven, of Manchester, and is worked by the admission of a small quantity of steam round the cones, by which means the air is exhausted from the train pipe. It will be seen that the boss of the handle carries a perforated plate. When the perforations correspond with others in the seat, air rushes in to destroy the vacuum and apply the brake, but the handle may be so placed that the rush of steam will carry away the air as fast as it comes. As the quantity of steam increases that of air diminishes, and *vice versa*, so that the amount of vacuum can be determined with the greatest nicety, and the brakes applied hard or gently at will. When the handle is in the position shown for running, a small quantity of steam is passed through the auxiliary cones, so as to maintain a steady vacuum of from 20 inches to 24 inches of mercury.

The train pipe communicates under each vehicle with a brake cylinder, C, Figs. 9 and 10. Figs. 4 and 5 are enlarged views of an engine and a carriage cylinder respectively, which closely resemble each other. Referring to Fig. 5—the carriage arrangement—we may observe that each cylinder, D, of cast iron is placed in a wrought-iron vacuum chamber, hung on trunnions to permit the piston-rod head to follow the versed sine of the curve described by the lever arm of the brake rigging. The piston-rod is packed with a rubber ring where it passes through the lower cover of the chamber. At F is a valve-box, containing a little gun-metal ball the size of a small marble. This is shown very clearly in Fig. 3. The ball is placed in a perforated cage, G, Fig. 3, and in front of it is an incline, the action of which is always to return the ball to its seat. When the piston is at the bottom of the cylinder, and the chamber is full of air, the ball will rest against its seat as shown in Fig. 3. The moment a vacuum is established in the train pipe by the ejector on the engine, the air will rush out from the cylinder direct through the cage, and it will also rush out from the vacuum chamber by pushing the little ball valve off its seat. As soon, however, as an equilibrium is established, the incline will return the ball to its seat. If, now, the vacuum is destroyed by admitting air to the train pipe, this air will find its way to the cylinder by passing through and around the cage; but it cannot get into the vacuum chamber, because the ball valve prevents it. The piston rises and the brake is put on, and it can be kept on as long as the vacuum holds good in the chamber, which is an indefinite period, when everything is in good order, because the piston and the ball valve are practically air-tight. The general arrangement of the cylinder and brakework on a carriage is clearly shown in Fig. 11 of our engravings. It also shows the universal coupling between the carriages, the details being all distinctly indicated by name.

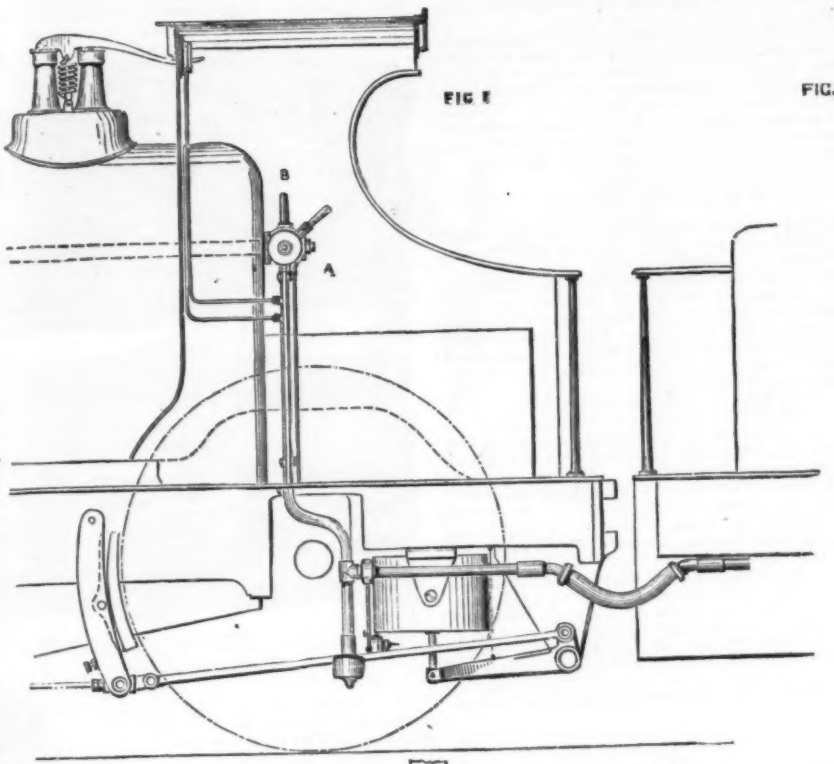
So far we have been dealing with the train as a whole, with its engine and tender coupled up. Now, if there were no further provision made than we have described, it is quite clear that it would be impossible to shunt a train, because the moment it was separated from the engine the brakes would go hard on, and, unlike the leak-off or two-minute vacuum brake, would remain on. To provide for this, a lever, shown in Fig. 3, is attached to the cage, G, and an elastic diaphragm is connected to this cage, so as to make the parts air-tight. By pulling at the lever the cage is drawn away, and with it the ball from its seat. Air then rushes in from the train pipe to the vacuum chamber, and the piston dropping, the brake is released. To the lever is attached a small wire leading to the side frame of the vehicle, and, when the brakes have to be taken off by hand, a porter runs along the train, and pulls each wire in succession. We are informed that this arrangement works without any trouble or unreasonable delay. The brake pistons are packed by means of rolling India-rubber rings, and work without friction, and quite air-tight. Moreover, no lubrication is required, which is of importance, seeing how exposed the cylinders are to dust and grit.

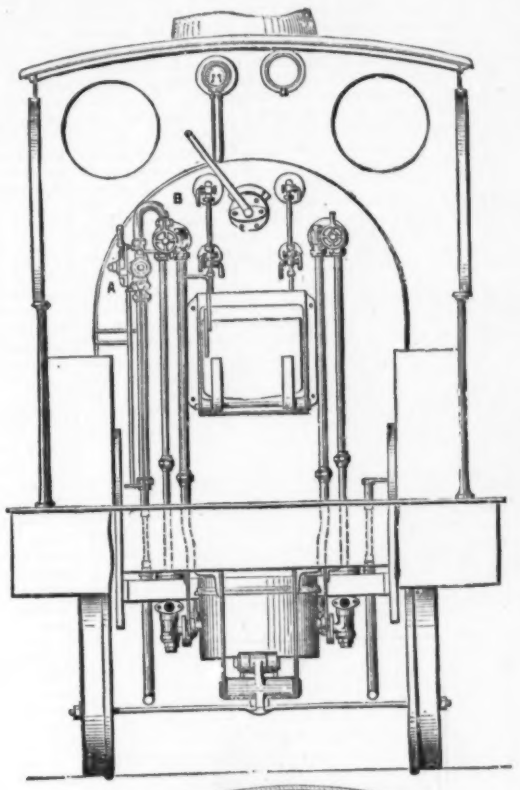
In order to be of any practical value, a continuous brake should be capable of being applied as instantaneously as possible throughout the whole length of the train. In the present case, if the air was admitted only at the engine end of the train pipe, a delay of several seconds must occur before the vacuum was destroyed at the tail end of the train. We need hardly point out that such a delay might prove—indeed, has proved—fatal in cases of emergency. To prevent this, the valve shown in section at Fig. 7 is fitted in each guard's van. It can be opened by the guard, but it also acts automatically. It consists of a flat valve, balanced by the aid of an elastic diaphragm. Through the spindle of the valve a small hole is drilled, and above the valve is a miniature vacuum chamber, H. When the process of exhausting the main vacuum chamber commences, the valve is held down hard on its seat, because there is air in the vacuum chamber, H, but in a little time the air all passes away from it through the little hole in the valve. The valve is now nearly in equilibrium, the air tending to pull it off its seat by acting on the diaphragm nearly as much as it tends to push it down by acting on the valve itself. The moment the vacuum in the train pipe is partially destroyed the balance is overset, and the diaphragm pulls the valve sharply from its seat, admitting air to the train pipe. In a few seconds the vacuum chamber, H, fills again through the hole in the spindle, and the valve then returns to its seat; meanwhile the brakes have been put on, which was the object in view. Besides what we have described, arrangements were shown at the exhibition for slipping coaches while the train is in motion, consisting of a pair of coupling cocks put in between the ordinary couplings of the slip portion and the rest of the train. A means of communication between passengers, guard, and driver was also exhibited. This is accomplished by means of a small pipe leading from the main brake pipe into each compartment, the ends of which are closed by a glass disk, the breaking of which makes the communication. The action of the brake mechanism was shown to be very perfect, the brakes being put on with any desired degree of pressure.

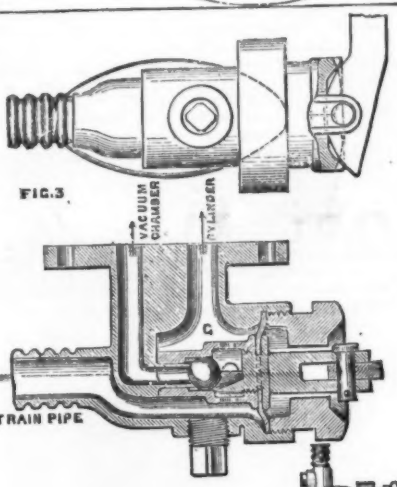
The advantages claimed for the automatic vacuum brake are: 1. It can be applied to a train of any number of carriages. 2. It is automatic, or self-applying,

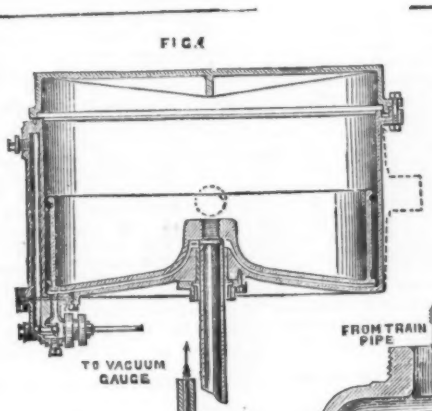
THE VACUUM AUTOMATIC BRAKE.

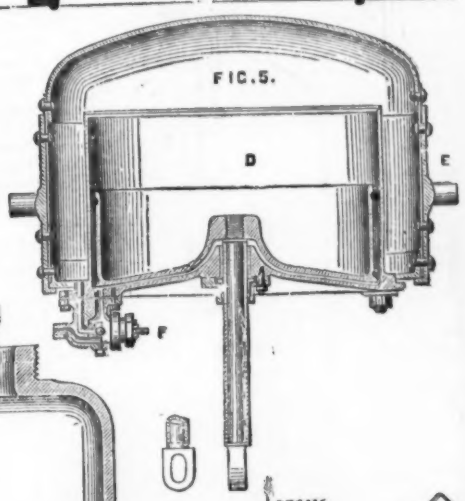
THE VACUUM BRAKE COMPANY, LONDON.

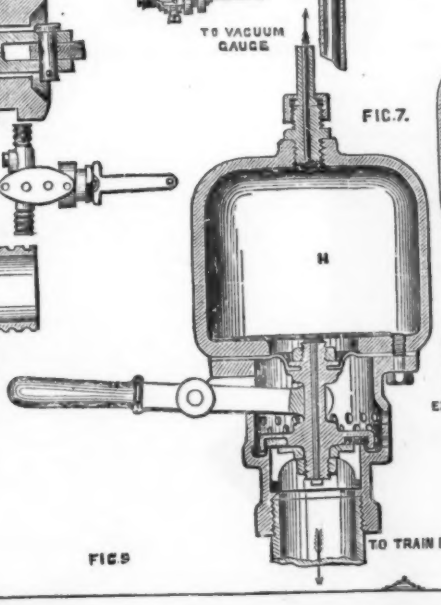


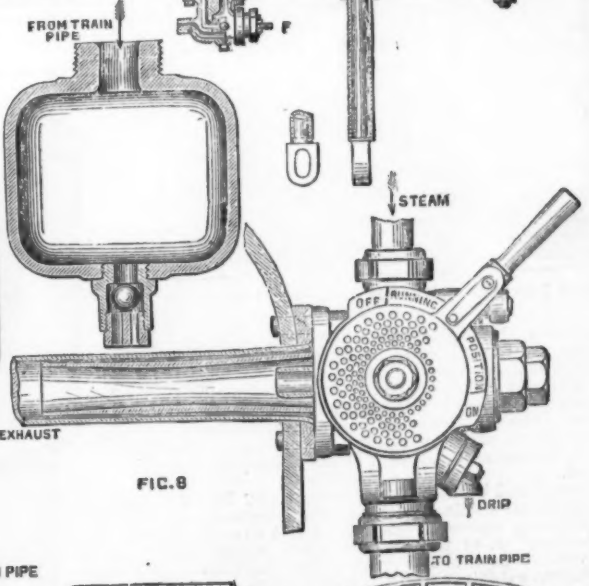


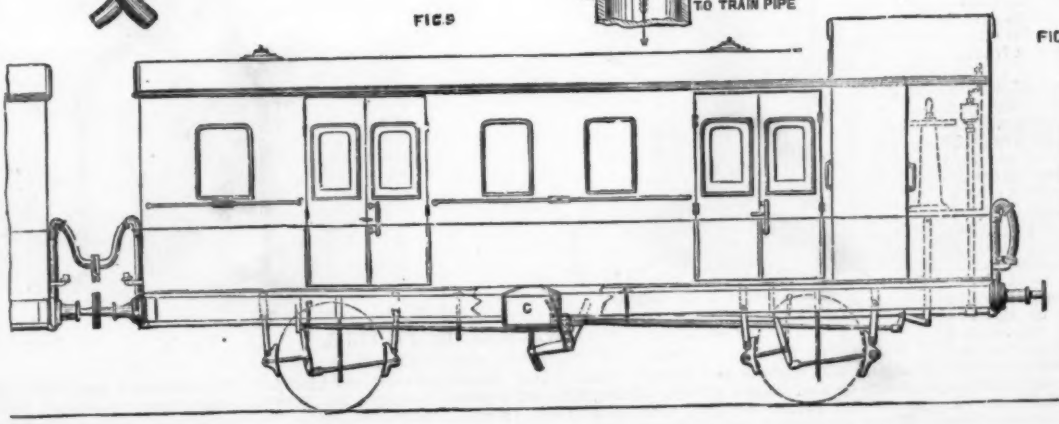


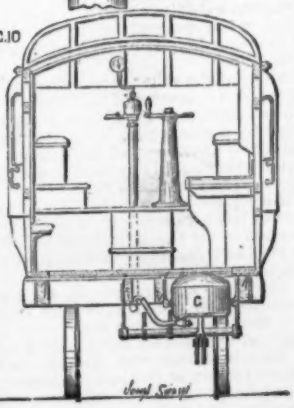












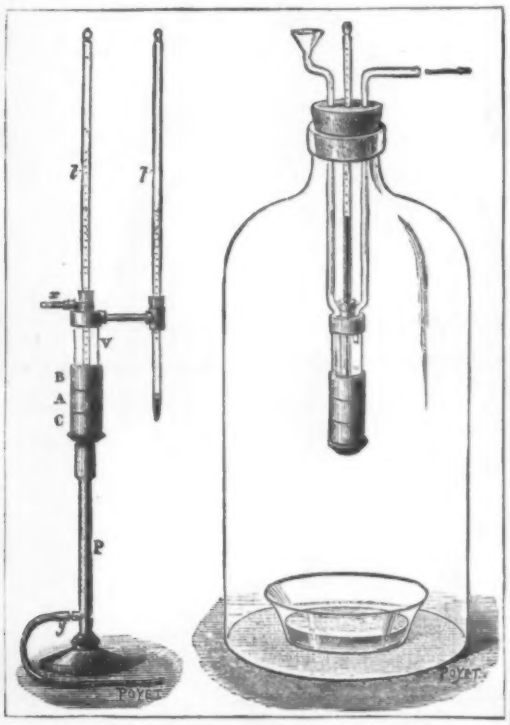
in case of accidental separation of carriages or damage to any of its parts. 3. It is instantaneous in its action. 4. The brake can be applied any number of times without exhausting its power. 5. Its force can be increased or decreased at pleasure, without removing the blocks from the wheels. 6. It may be applied with any amount of pressure for retarding a train down an incline of any length, while its full power is at command for instantaneous application by driver or guard. 7. The joints are easily kept tight, and there is no tendency to burst the connecting hose. 8. Economy in the use of steam, a very small ejector being capable of maintaining the vacuum. 9. Simplicity. The brake is applied, regulated, and released by one handle. No pump or separate reservoir on engine required.

With regard to the adoption of this brake by railway companies, we may mention that it is now largely in use in this country, as shown by the Board of Trade returns; also in India and upon the Continent. We are informed that during the last half year the Lancashire and Yorkshire Railway Company ran 2,358,528 miles with this brake, and that the Vacuum Brake Company have instructions to fit the whole of that railway company's stock with it, which means 3,000 carriages, besides brakes for the engines. The Midland Railway Company are now fitting the ball valve to their cylinders, so that their brakes will soon be similar in every respect to those with which the Lancashire and Yorkshire, the Taff Vale, the South-Eastern, the Great Northern, the London and South-Western, the Northern of Belfast, the Glasgow and South-Western, the Highland, the Furness and the Mersey Railways are now fitting their stock.—*Iron.*

A NEW CONDENSATION HYGROMETER.

THE apparatus represented herewith, one-fifth actual size, is a modification of Regnault's condensing hygrometer, and is the invention of Dr. G. Sire, of Besancon.

It consists of a cylindrical reservoir, A, of thin brass, silvered and polished externally, into which is poured



FIGS. 1 AND 2.—SIRE'S HYGROMETER.

sulphuric ether, the temperature of which is gradually lowered by passing a current of air through it until the polished surface shows a slight deposit of aqueous vapor. The dew-point temperature is given by a thermometer, *t*, whose cylindrical reservoir is immersed in the ether in the direction of the appparatus' axis. The temperature of the ambient air is furnished by another thermometer, *t'*, situated in the vicinity of the instrument.

Two silvered and burnished thin brass rings, BC, of the same diameter are fixed, through the intermedium of an insulating material, one above and the other below the part, A, of the reservoir upon which the aqueous vapor deposits. The result is that this part of the instrument exhibits externally a cylindrical surface having the same generatrix, but divided into three zones of the same height by two intervals of a fraction of an inch each.

The bottom of the ether reservoir consists of a block of ebonite. The diameter of this reservoir is one inch at its widest part, and its height is two inches. It is surrounded by a glass tube, V, through which may be ascertained the intensity of the current of air that traverses the ether bubble by bubble, and that enters the apparatus through a plunge tube whose orifice is at *x*. Finally, the whole is supported by a stand, P, which forms part of the arrangement adopted for producing an inspiration of air through the tubulure, *y*, to which is fixed a rubber tube connected with an aspirator.

The important features of this arrangement are as follows: (1) The end rings, B, C, remain bright in the experiments, so that it is very easy to judge *by contrast* of the least changes that occur in the central one, A; (2) the cylindrical surface of A offers the advantage that it shows such changes in all azimuths; and (3) the addition of the two extreme zones or rings, as well as of the ebonite bottom, prevents the reservoir from being heated by the surrounding air in any other part than that on which the vapor deposits; the temperature of the deposit is more quickly reached, and it is more easily kept stationary.

This new instrument is remarkable for being of small size without being fragile, and for its portability and the quickness with which it may be put into position. It is very sensitive, and Regnault's directions for maneuvering his apparatus are also applicable to this.

The instrument is so small that it may be introduced into a bell glass to ascertain the hygrometric state of the interior. It is in this case lightly modified, and arranged as shown in Fig. 2, where the ether is evaporated by sucking in air through the instrument from the outside.

If several hair hygrometers be arranged in the atmosphere of the bell, whose degree of moisture is varied by mixtures of water and sulphuric acid, it will be possible to accurately determine their indications to within as small fractions as may be desired. This experimental process constitutes a very exact method of graduation and verification for hair hygrometers, and is, moreover, a very expeditious one.—*La Nature.*

THE WACKERNIE FILTER.

THE filtering apparatus devised by Mr. Wackernie are of two kinds—tubular filters of wide surface and mechanical ones.

The decanting tubular filter consists of a cylindrical reservoir of galvanized sheet iron, divided into two compartments or chambers by a horizontal disk which supports a series of filtering tubes. These latter, which hang vertically in the lower chamber, are of perforated copper, plastic material, or some sort of fabric, according to circumstances.

If it is water that is to be filtered, the decanting filter performs the role of a preparatory apparatus. In this case, the tubes are of perforated copper. The water enters the reservoir, traverses the tubes, and passes into the upper chamber.

The mechanical filters consist of cylindrical reservoirs divided into three compartments by horizontal perforated partitions. Each of these compartments contains a granular filtering material, which varies according to the nature of the liquid to be filtered. Whatever be the latter, Mr. Wackernie has observed that it is necessary to employ two filtering materials, to wit a spongy one, that takes up the impurities, and a non-absorbent one, that acts by capillarity. If it is water that is to be filtered, the spongy material used is a very pure mineral carbon, which Mr. Wackernie styles "spongy carbon," while the clarifying one is pure silex reduced, like the carbon, to a proper granular state.

A complete, industrial filter is formed by arranging alongside of the decanting apparatus two mechanical filters, one of them containing two layers of carbon and one of silex, and the other, one layer of carbon and two of silex. The water traverses these apparatus from bottom to top.

Cleaning is effected through a reversal of currents by means of steam or of pure water under pressure.

If a chemically pure filtrate be desired, it is easy to substitute animal charcoal for the silex of the first filter. For domestic purposes, Mr. Wackernie is constructing simpler apparatus, like those shown in the accompanying engravings. One of these (Fig. 1) is a fountain filter capable of discharging fifteen gallons per hour. The water is poured into the reservoir, A, in which there is a movable filtering vessel containing animal charcoal, the action of this being indispensable for removing the organic principles and the excess of salts held in solution in the water. The latter, after traversing the charcoal, passes through a layer of silex in the cylinder, B, and makes its exit through the cock, D.

Fig. 2 represents a pressure filter capable of discharging 328 gallons per hour. The water enters through G, and makes its exit through H, after passing through layers of spongy carbon and one of silex.

These apparatus are cleansed mechanically about once a month. In the pressure filter this operation is performed by closing a cock at G, and opening a cock at H, and the purge cock, I. As regards the other apparatus, when the reservoir is empty, the purge cock, E, and the cock D are opened simultaneously.—*Chronique Industrielle.*

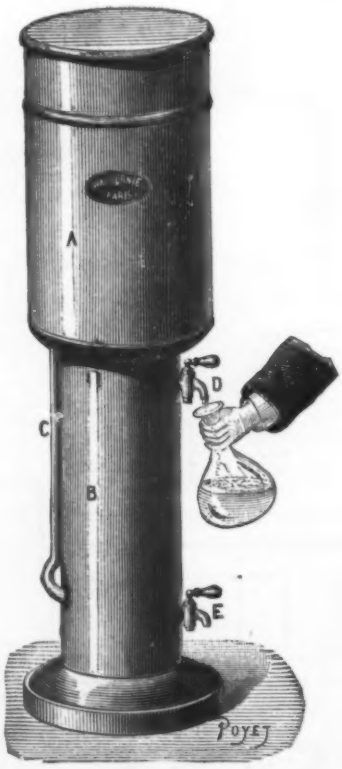


FIG. 1.

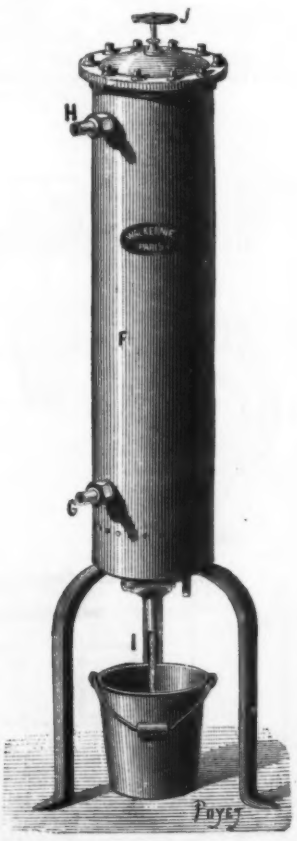


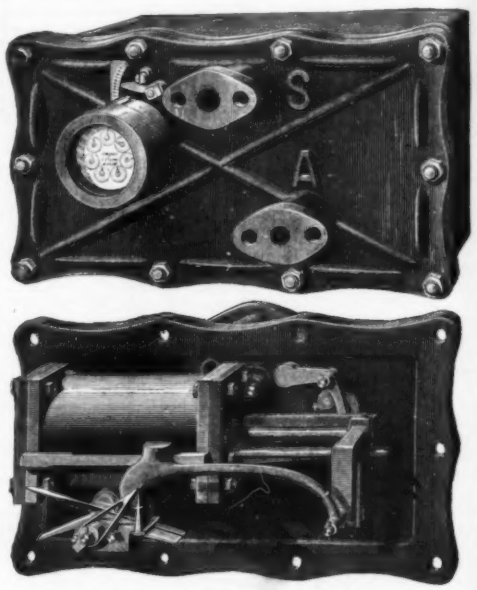
FIG. 2.

WACKERNIE FILTERS.

BERTHON AND DEBENOIT'S WATER METER.

MESSRS. BERTHON AND DEBENOIT propose a new style of water meter, of which the *Bulletin de l'Industrie Francaise* gives a detailed description.

The apparatus, Figs. 1 and 2, consists of two parts,



FIGS. 1 AND 2.—BERTHON & DEBENOIT'S WATER METER.

(1) of a double acting pump chamber, having two entrance and two exit orifices; and (2) of a distributing box, having four orifices that coincide with those of the cylinder. To the head of the piston rod there is fixed a piece which forms a slide, and which is connected with a lever that actuates the hands of the dial. This same piece carries two tappets, which, in case of accident to the apparatus, oscillates the lever so as to cause it to close the exit orifice. Another lever, in the form of a hammer, bears against the lever adjoining the distributing key. The back part of this latter forms a hollow cylinder, which the water enters, and then makes its exit from the orifice when the latter is not closed. The back part of the key is hollowed out in such a way as to leave the necessary space for the flow of the liquid at the moment desired.

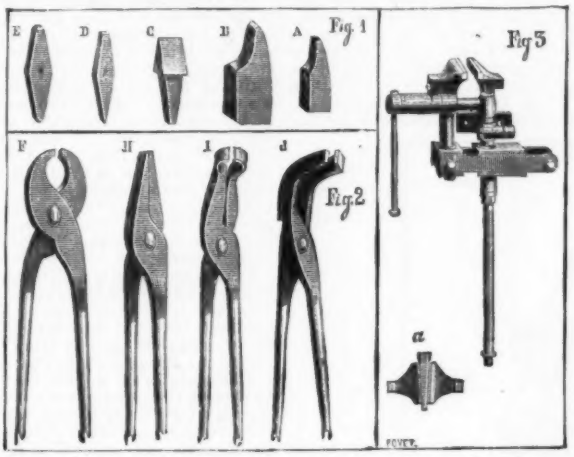
On the distributing box side there is a stationary piece designed to receive the blows of the lever hammer in its changes of position. To this piece there is attached by an axle another small lever of triangular shape, which is capable of oscillating under the head of the lever hammer. This latter is sufficiently heavy to cause the key to play through contact with the latter's handle. The travel of the triangular lever to the right and left is limited by stops.

The meter is wholly of metal, and is therefore adapted for measuring hot liquids, especially feed water, and boiling beet juice in sugar works. When the system is applied to the feeding of steam boilers,

there is interposed a retaining box and a suction valve. The inventors claim the following advantages for this apparatus: a considerable reduction in friction, due to the suppression of packing; possibility of operating under the action of but a 10 inch column of water; and saving in cost of putting in.—*Le Genie Civil.*

FORGE AND WORKSHOP FOR AMATEURS.

THE implements required are few and inexpensive—a portable forge, an anvil, a hammer, and some tongs; that is all. For a few dollars there may be procured a small forge like the one shown in Fig. 4, and which will answer sufficiently well for the heating and welding of a bar of iron an inch square. The amateur who would like to work larger pieces, as there is sometimes occasion to do, can, for a few dollars more, procure a forge capable of heating a bar three inches square.



FIGS. 1 TO 3.—CHISELS, HAMMERS, TONGS, AND VICE.

The anvil selected should be of hard iron, with a very true upper surface or plate. When struck, it should emit a clear, silvery tone, a good anvil being known by its perfect sonorousness. Anvils are made both of cast iron and steel. The former are not fit for use, because they are apt to become grainy and break. The steel ones last longer, but cost more, and also sometimes break in consequence of defective tempering. The anvil selected should be of the kind used by locksmiths, that is to say, one having two beaks, one of

FIG. 4.—PORTABLE FORGE.

them round and the other pyramidal, and both provided with apertures. Of the latter, one is square and serves to receive the shanks of the chisels and swages, while the other is cylindrical and traverses the pyramidal beak. This aperture is very useful in many cases, for example, when hot iron is being punched. The anvil should weigh from 120 to 130 pounds. When lighter than this, it does not offer sufficient stability. It is set upon a wooden block (usually a section of the trunk of a tree) in such a way that the upper surface or face shall be about on a level with the workman's waist, the conical beak to the left. In order to deaden noises and vibration, a bad conductor (straw matting or rubber) is interposed between the block and

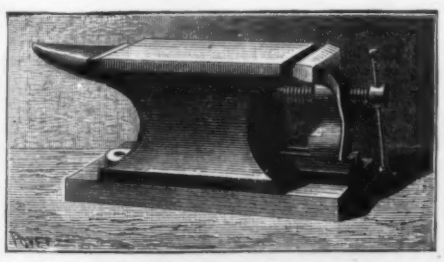


FIG. 5.—ANVIL FOR AMATEURS.

the floor, and one of the beaks is surrounded with a leaden ring that may be taken off at will. Fig. 5 shows a style of anvil of American manufacture, especially designed for amateurs. The addition of a vise is a happy innovation, and ought to much facilitate the work.

Two forge hammers, one of them light (A, Fig. 1), weighing less than two pounds, and one heavier (B), weighing from four and a half to six and a half pounds, are sufficient. The last mentioned is perhaps not adapted to every biceps, but half an hour's work with such a tool is worth an hour's exercise with dumb-bells. The hammers must be purchased ready for use, with strong, firmly fixed handles.

At C, in Fig. 1, is shown the chisel which is to be inserted in the square hole in the anvil beak, and upon which is to rest the piece of iron to be cut. D and E represent other forms of the tool, called cold and hot chisels, according as they serve for cutting cold or red hot iron. For these there may be substituted a strong cast-steel cutting tool. At F, H, I, and J, Fig. 2, are shown the most usual forms of tongs. Many others may be found among manufacturers, but it is useless to lay in a stock of them, for in this way one often buys tools that he never has occasion to use; and, besides, the amateur will soon be able to forge for himself all the implements of this nature that he may need.

As accessories to the forge must be mentioned a barrel or large bucket full of water for tempering steel, cooling iron, and wetting the latter through the intermedium of a watering brush. A necessary complement of the forge is a workshop. This requires a much more complex set of instruments, into the details of which we cannot here enter. We shall merely give some advice regarding the selection of certain very important tools, such as the vise, drill, etc.

The vise is the all-important tool of the shop, and for this reason too much care cannot be exercised in its purchase. We strongly advise the amateur to procure a revolving vise like that shown in Fig. 3, having jaws of a minimum width of 6 inches. When smaller than this it is not serviceable, and will not withstand the blows of a hammer when chipping is being done, or when hot pieces of some sizes are being shaped.

The oblique clamping (*a*, Fig. 3) permits of locking firmly in the vise such slanting pieces as are always badly held in an ordinary instrument and sometimes cause the breakage of the screw threads. This arrangement, then, offers a great advantage and more security.

The drill serves for piercing iron and analogous metals. In Fig. 6 we represent the kind that we use in our shop. It is of the style called a bracket drill. It consists of a strong iron bracket fixed to the wall, and capable of swinging in a half-circle on the arc, C, on which it is arrested in any desired position by means of the binding screw, P. A strong screw, B, maneuvered by one hand, presses against the brace, V, that carries the drill. This screw can be pulled forward or shoved back, and held in position through the pressure of the screw, P', against the arm that supports it. When the work is finished, the brace is removed and hung up on a nail, and the bracket is shoved against the wall.

This apparatus in addition to being very convenient, is very powerful, and permits of drilling holes of large diameter, which is something that cannot be done with those small bits and braces that we find in all hardware stores. Yet we must remark that in some amateur shops we have seen ratchet drills like those found in large workshops. Aside from the fact that such machines are costly, they are very dangerous, and we cannot recommend them.

In Fig. 6, to the right of the drill is shown an instrument that is rarely found among amateurs. It consists of a perfectly planed cast iron plate upon which slides a cast iron or bronze standard that carries a point which through adjusting and binding screws, is capable of taking any desired position.

It is with this device that we trace such pieces as we desire to work, according to any given plan. Such is the role of the sketcher in large shops, whither we strongly recommend our amateur readers to go in order

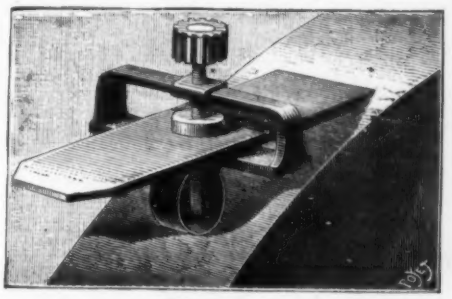


FIG. 7.—APPARATUS FOR SHARPENING TOOLS.

to see how a piece is traced. And, moreover, let us say, apropos of this, that in order to learn any manual labor whatever, it is especially necessary to see it done. It will prove very advantageous to the amateur to take a few lessons on the lathe and forge from a mechanic, and to complete his education by reading, observation, and repeated experiment. Such is the method that we ourselves followed, and there is none other if it be desired to quickly obtain a good result.

A grindstone of large diameter is indispensable in the shop, for sharpening cutting tools, such as chisels, drills, etc. In Fig. 7 we represent a small and ingenious instrument for holding the tube that is being sharpened in an invariable position, so as to obtain a perfectly regular bevel, this being a necessary condition to obtain a good cutting edge. By holding the tool in the hand simply, no good result can be obtained, except by long practice.

The amateur will procure files, pincers, draw plates, etc., in measure as he needs them. According to his tastes and circumstances, any one may undertake very varied operations that require a certain number of appropriate tools. For this reason it would be of no interest to enter into further details.

It now remains to say a word as to the amateur's costume, and the precautions that he should take while doing his work. Although he need not put on the ordinary suit of a mechanic, he should nevertheless

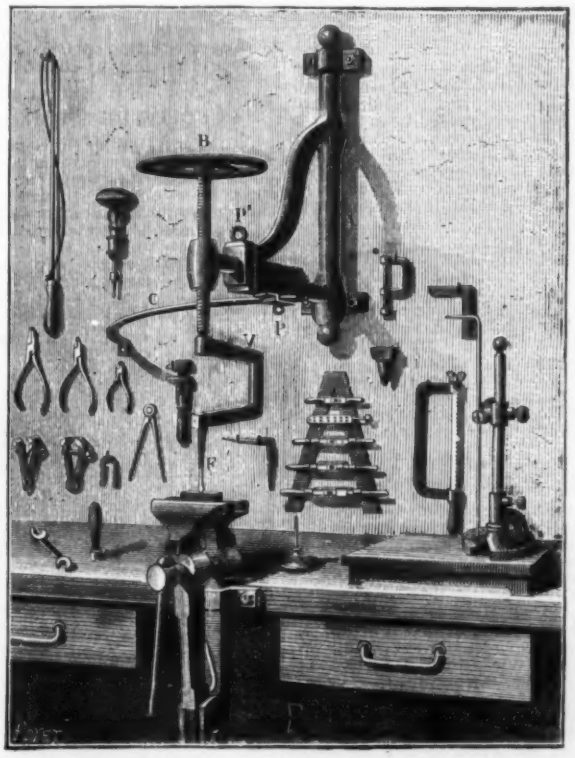


FIG. 6.—AMATEUR WORK BENCH AND TOOLS.

wear a long blouse, in order to protect his clothing, which, without such a precaution, would soon get spoiled. In forging, a coarse canvas apron should be worn. In turning and chiseling, and in forging steel, it is prudent to protect the eyes with a pair of large, round, miller's spectacles. The neglect to do this may lead to serious accidents. Many amateurs wear gloves while at work, and this is the best thing to do to prevent callosities, excoriations, cuts, and that host of

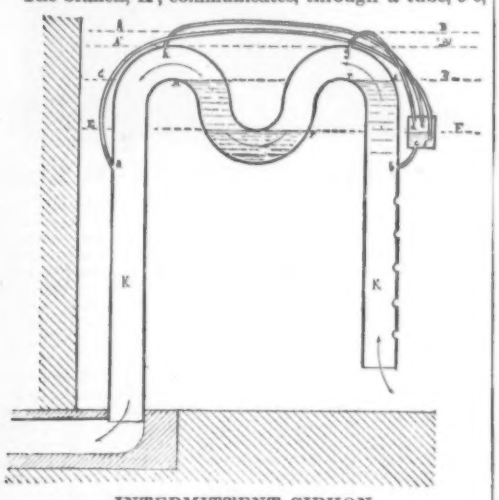
small accidents that are so disagreeable and troublesome. In cleaning the hands, which metal working soils so, we recommend the use of benzine, which we prefer to vaseline as being more convenient to use. It is only necessary to rub the hands with a rag saturated with benzine to quickly remove grease, varnish, paint, cement, etc. After this, a washing with ordinary yellow soap will render the hands clean.

Although we have finished what we had to say about amateur mechanics, we certainly have not exhausted the subject. This we could not do, nor would we desire to, but we have a conviction that we have given some practical advice, which has been dictated by our personal experience, and which is sufficient to prevent novices from making many mistakes.—*La Nature.*

INTERMITTENT SIPHONS.

MR. DELAVALLADE has invented a system of siphons which, although of large dimensions, are primed with a very small quantity of water. These apparatus are designed for the irrigation of meadows in cases where there is a scarcity of water, and where the latter has to be collected in reservoirs for subsequent distribution over wide areas. There are various forms of the apparatus, one of the most ingenious of them being that which we represent herewith. It consists, as shown in the figure, of two branches, K K', connected by a thrice curved pipe of the same diameter. This is placed in the reservoir with the larger branch, K, in communication with the outlet.

The branch, K', communicates, through a tube, *b c*,



INTERMITTENT SIPHON.

of small diameter, with a chamber of about the capacity of a beer glass. This latter is connected with the top of the curve of the long branch by a tube, *e h*, that rises above the level, A' B', and with the curve of the short branch by a tube, *d g*. The extremities, *d* and *e*, enter the chamber. Finally, a third tube, forming a siphon, starts from a point, *a*, of the branch, K, and ends at *f*, a few fractions of an inch from the bottom.

The diameter of the tube, *b c*, is smaller than that of the others, and the one forming a siphon passes over the line, A' B', and under the tube, *e k*. Upon rising in the reservoir, the water ascends the branch, K', as far as to *r s*, and at this level enters the small tubes after filling the chamber, F. After this, if it continues to rise in the reservoir, the bent pipe that connects K and K' will become full up to *o p*. The air imprisoned between *o p* and *r s* becomes compressed in measure as the level in the reservoir rises above C D. The water rises in the branch, *o m n*, to a degree equal to that to which it rises above C D in the reservoir. If the distance between E F and C D, is greater than between C D and A' B', the liquid cannot reach *m n* until after it gets beyond A' B' in the reservoir. When the level of the latter reaches the top of the siphon, *f a*, the latter becomes primed, the chamber, F, empties, and the small quantity of water in the tubes, *d g* and *e h*, flows out. As the tube, *b c*, is of smaller diameter than *f a*, the chamber, F, cannot fill again. The extremities of the tubes, *d g* and *e h*, then remain free, and as the imprisoned air can freely escape, the large siphon becomes primed in its turn, and empties the reservoir.

The branch, K', is provided with apertures at different heights, which are closed or opened at will, and which permit of regulating the depth to which it is desired to empty the reservoir.—*Chronique Industrielle.*

MINERALOGICAL MICROSCOPE.

FOR ten years past we have been fighting to get makers to adapt to their microscopes those improvements which make the American and English instruments the best in the world, at least as regards conception and mechanism. The mode of construction recently applied in our "Continental" microscope was the first practical attempt in this direction. Mr. E. Bertrand, the well-known mineralogist, has just made a second one in the construction of his mineralogical microscope, and one that is particularly happy, since, without such transformation of the mechanism, the application of the microscope to mineralogy is absolutely impossible.

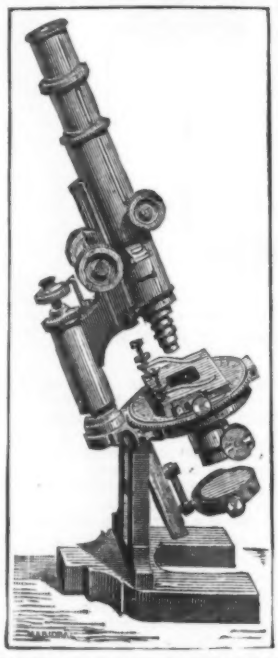
This instrument, which Prof. Mallard of the School of Mines justly places in the first rank, has not been in the market up to the present, but is now being constructed right along by the celebrated house of Hartnack & Prazmowski (now carried on by Messrs. Begu, Hausser & Co.), which has made as nearly as perfect an instrument as possible of it.

The instrument is supported by a solid horseshoe-shaped iron base, and is, including the analyzing ocular, 18 inches in height. The tube, which is of ordinary length, does not draw out. The quick movement is effected by means of a rack, and the slow by means of a screw that has a pitch of $\frac{1}{175}$ of an inch. The head of this screw carries a division that permits, through an index, of estimating movements of $\frac{1}{1000}$ of an inch and even less. The rack is prismatic, thus securing a faithful and permanent centering.

In front of the tube there is another rack, that actuates a piece provided with two apertures, one of them free for allowing of a parallel passage of the light, and the other for holding an achromatic lens for convergent light.

Under the aperture through which this piece passes there is another one, designed for the reception of sensitive plates, etc.

The nose of the microscope is provided with an adapter that replaces the screw of the objectives. This is mounted upon a spring, and is provided with lateral screws for the perfect centering of the objective. The body, along the rack, carries a scale and a vernier, which permit of measuring the thickness of specimens. The circular graduated stage revolves, as in English microscopes, around the optical center, and its movements are measured by an index vernier. It can be revolved either rapidly by hand or slowly by a lateral screw. On the stage there is a rectangular sliding plate, which may be moved backward and forward and



MINERALOGICAL MICROSCOPE.

laterally by means of two screws with milled heads, the motions in either direction being measured by a vernier scale.

Under the stage there is a substage provided with an eccentric and rack, and arranged for receiving the polarizer and illuminating apparatus. The mirror is double—plane and concave—and is capable of being given any position.

The instrument is accompanied with a No. 1 eyepiece with a hair cross, an ordinary No. 3 one, and a Bertrand one. The objectives are a Hartnack & Prazmowski immersion one, No. 9, and Nos. 4 and 7 dry. There is also a goniometer cup, which serves both for measuring the optical angles of crystals and the indexes of refraction.—*Dr. J. Pelletan, in La Nature.*

OCHOROWICZ'S THERMOMICROPHONE.

THE reason that we have not sooner spoken of this apparatus is because we hoped to obtain some additional details that would have allowed us to explain away the mystery that surrounds this new telephone. Unfortunately, its inventor still remains mute.

Dr. Ochorowicz's apparatus, which he calls a thermomicrophone, was presented by him for the first time in public at a meeting of the International Society of Electricians on the 4th of February last.

The second exhibition was made to the French Society of Physics, and more recently still Mr. Napoli, during the course of an interesting lecture in the large amphitheater of the Arts et Metiers, has shown all the advantages that are offered by this system. Finally, the Electrical Exhibition has made the new apparatus known to entire Paris.

In each of these cases the effect produced was wonderful. In his communication to the Society of Electricians preceding the presentation of his thermomicrophone, Dr. Ochorowicz gave a few explanations of the magnetic receiver of his apparatus, but he asked permission not to enter into the details of its construction. The permission was granted very willingly, because it was impossible to do otherwise.

The receiver consists of the three constituent elements of all telephones—magnet, bobbin, and vibrating plate—but with a changed arrangement.

Dr. Ochorowicz makes use of two parallel vibrating plates, between which are two bobbins, whose cores, traversing the lower plate, are fixed to a cylindrical magnet split lengthwise. These plates, which are of sheet iron, are held by their edges upon a cylinder forming a sort of resonating box. The constant magnetization acts continuously upon the two plates, and keeps them attracted toward one another, and slightly depressed. In this state, the undulatory current that starts from the transmitter and enters the bobbins increases or diminishes the flux of force of the magnet, and produces those contractions in the plates that form series of vibrations. Some assert that the presence of two vibrating disks is one of the causes of the superiority of this apparatus, and we are of this opinion ourselves.

The transmitter is a microphone of which the details of arrangement are still kept secret. It is merely stated that the microphonic mass is considerable, that the contacts through which the current enters are very small, and that the vibrating plate is of mica. According to the *Revue Scientifique*, the mysterious transmitter consists of an agglomeration of metallic particles that close the circuit and modify the circulation of the current by reason of the variations of the magnetic field, which is itself modified by the variations of a diaphragm. In order that the microphonic sensitiveness shall be at a maximum, the metallic particles must be heated by the current.

This new transmitter operates with ten Callaud elements or four small accumulators. It has no induction bobbins, and is a direct transmitter. This arrangement would lead us to believe, to judge by experiment and theory, that the results would not be so satisfactory were the length of the circuit to be notably increased.

If we replace the microphone by a transmitter identical with the receiver, the sounds obtained are not so loud. They can, however, be perceived at a distance of one or two yards from the apparatus.

The name thermomicrophone sufficiently indicates that heat plays a preponderating role in the system. Moreover, from the experiments performed by Dr. Ochorowicz on the different occasions that we have cited, it results that the microphone has to be heated in order to regulate it. But farther than this the inventor does not take us into his confidence, and the hypothetical side gives rise to a supposition that is perhaps not without value. As well known, conductivity in a non-metallic body, liquid or carbon, increases with heat, and, *per contra*, the resistance diminishes.

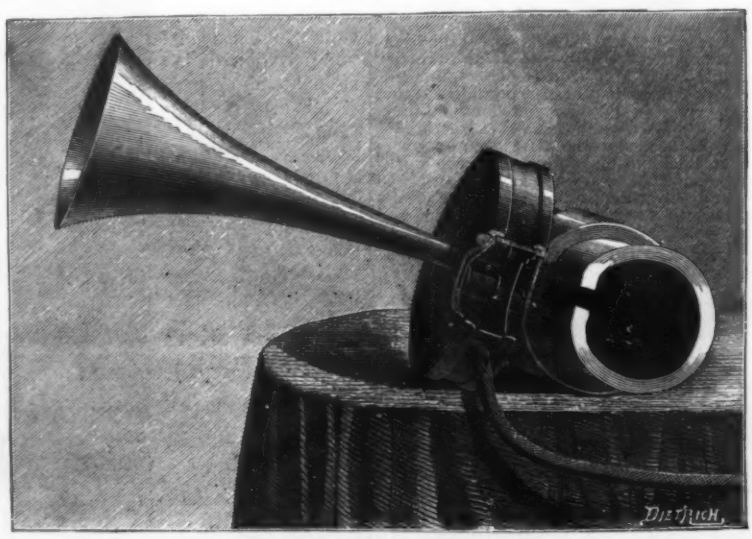
On another hand, we know that in an incandescent lamp of sixty ohms resistance, for example, such resistance is no more than about thirty ohms when the carbon has acquired a certain temperature. From these facts arises a hypothesis which is not at all improbable, and that is that in the thermomicrophone the intense current of the Callaud pile produces an elevation of the carbon's temperature and thus facilitates the transmission.

But let us not anticipate; let us drop the mysterious veil that shrouds an apparatus that we shall again have something to say about after Dr. Ochorowicz has spoken.—*Science et Nature.*

DISRUPTIVE DISCHARGES THROUGH SOLIDS AND LIQUIDS.*

By Messrs. TARQUEM and DAMIEN.

THE optical properties of discharges through gases and vapors have been carefully studied for thirty years by a large number of observers. As well known, the electric spark produced under such circumstances has the effect of rendering incandescent the more or less dissociated molecules of the medium that it is traversing, and of giving, with the molecules reduced to a state of atoms, Plucker's spectra of the second order.



OCHOROWICZ'S THERMOMICROPHONE.

* *Journal de Physique*, IV., p. 457.

that is to say, narrow luminous bands; and, with non-dissociated molecules of simple gases, or with those of compound ones, continuous spectra with wide dark bands—spectra of the first order. These two spectra often coexist or succeed each other when the intensity of the discharge is increased. No work on electricity or spectroscopy speaks of the radiations emitted by electric sparks occurring in a solid or liquid dielectric. It has appeared to us to be of interest to ascertain the nature of these radiations. In the first place, we took a strip of glass about a centimeter thick, that was perforated by a discharge from a Holtz machine by the process usually employed, that is to say, by placing the strip smeared with oil between two other strips that were traversed by the electrodes. The spark may be easily examined with the spectroscope through the edge of the glass without the latter having been smoothed and polished.

1. If a feeble discharge (that of the machine) be employed (the Leyden jars being suppressed), we first observe a *continuous spectrum* from which a few brilliant bands shortly detach themselves in the yellow and violet, and which are due to the air that gradually enters the channel traversed by the spark.

2. If the intensity of the discharge be slightly increased by adding the jars, but without interrupting the conductors running from the machine to the glass, or but slightly interrupting them, we see the sodium line, D, appear as a brilliant line in the continuous spectrum.

3. Upon still further increasing the intensity of the discharge by a further separation, the brilliant line, D, will be suddenly replaced by a black band, produced by the absorption of the gaseous atmosphere of the sodium vapor around the spark.

We tried other transparent substances, and endeavored as far as possible to prevent the entrance of air into the channel traversed by the spark. Crystallized substances, such as sal gemmæ and spar, were immediately broken. Other solid substances, such as quartz, flint (with potash for base), and copal, likewise gave a continuous spectrum without any brilliant band, so long as the air was unable to enter the channel. We afterward tried water and other liquids. With water, even when distilled, it is almost impossible to obtain disruptive discharges with the Holtz machine, even by insulating, up to their extremity and with the greatest care, the platinum wires between which it takes place. It is necessary to produce a notable interruption in the conductors, and the sparks are then very discontinuous, and a spectroscopic study of them is very tiresome, and the more so in that the spark is exceedingly brilliant. Moreover, it is necessary to use very wide vessels, in order to prevent them from being broken by the discharge. In this case we preferred to use a large Ruhmkorff coil that gave an eleven-inch spark in the air between a negative plate and a positive point. We also added to the coil four large jars on derived circuits, and a variable distance interrupter interposed upon one of the conductors prevented the induced current from being continuously closed by the liquid. With distilled water, as with other insulating liquids, such as petroleum, we always obtained a very brilliant, conspicuous spectrum, especially remarkable for the intensity and extent of the violet portion, which much exceeded the field of a spectroscope employed for the study of a solar spectrum, in which the line H is toward the limit of visibility. The addition of a fluorescent substance to the liquid in no wise changed the aspect of the spectrum.

We should have liked to try salt water, but it was impossible for us to cause disruptive discharges to pass by the preceding process; it is necessary to employ battery discharges, and this is very inconvenient as regards observation.

How are these phenomena to be explained? It seems probable that the discharge causes the decomposition of the liquid molecules that transmit it; but the incandescent gases derived from such decomposition give a continuous spectrum like gases in combustion, and the larger portion of these gases becomes recomposed immediately after the passage of the spark—a small portion being disengaged. Moreover, we must admit that the pressure of these gases is considerable at the moment of their production, a fact that would explain the brilliancy of the spark. It would, in fact, be difficult to suppose molecules of water raised to incandescence through the passage of the discharges.

THE TELEPHONE LITIGATION.—THE DOLBEAR CASE.

To the Editor of the Scientific American:

There have probably been very few recent discussions of the various issues of telephone litigation that have overlooked alleged recognitions of Bell as the original and first inventor of the telephone, the cases cited being Bell vs. Spencer and Bell vs. Dolbear.

I shall not undertake any discussion of the Spencer case, preferring to await an investigation of the allegations which have recently been made in the hearing before Secretary Lamar as to the good faith of that suit.

As to the Dolbear case, I think that a few words of explanation will be of general interest.

In your issue of Nov. 28, you quote Judge Gray as saying, in the Dolbear case: "It was decided in the Spencer case, and is not denied by the present defendant, that Bell is the first inventor of a speaking telephone." It is true that in granting the motion for a temporary injunction he used the words quoted, and thence has arisen a belief, very generally held and frequently expressed, that the Bell monopoly has been strengthened by admissions made by the defendants in the Dolbear case. Whether this belief is justified by the facts can best be determined by reference to the defendant's answer to the bill of complaint, in which document the following statements occur:

"They admit the grant of the Letters Patent in the bill of complaint mentioned, No. 174,465, dated March 7, 1876, and No. 186,787, dated January 30, 1877.

"They deny the complainants' title to said Letters Patent.

"Electric speaking telephones had been publicly known and used long before the grant of the Bell patent of 1876, and it is matter of general knowledge among all skilled in the art that Philipp Reis invented an electric speaking telephone before 1863, which was so widely known by means of printed publications in the English language and in foreign languages that the apparatus and method of Reis were public property in 1876 and before that year. Reis' telephone was made public before 1870, was a matter of great interest among electricians in this country and in Europe, full and accurate knowledge of it was had by large numbers of electricians in this country, and in Europe; and it was so well and widely known, both in this country and in Europe, that the Bell apparatus is now, and has always been, considered, by large numbers of electricians, not as the first electric telephone, nor as the first electric speaking telephone, but merely an improved form of telephone. Before 1876, telephones, electric telephones, electric speaking telephones, and mechanical speaking telephones were so well and widely known that at the date of Bell's invention they were public property, not to be monopolized lawfully; and Bell's invention was an improvement in an old art, and was not a new art. Therefore, these defendants deny all the allegations in the bill of complaint as to Bell's being the first or an original inventor of a new art or of a new apparatus, and aver that his invention was nothing more than an improvement on what was well known before to all skilled in the art of telephony, including Bell himself.

"The Reis telephone is an efficient electric speaking telephone. Its currents are the so-called undulatory currents, and are precisely the same as one class described in the Bell patent of 1876. The Reis-Legat telephone is an efficient electric speaking telephone. Its currents are the so-called undulatory currents, precisely such as are expressly included in the Bell patent of 1876. The Reis-Wright telephone is not a speaking telephone; but the currents in its primary circuit are the so-called undulatory currents, precisely such as are expressly included in the Bell patent of 1876. And while the electricity generated in its secondary circuit, or line wire, is substantially different from that in Bell's line and the line of Reis-Legat, that arises solely because of the use of a different receiver; and with the Reis-Legat receiver substituted for the Wright condenser receiver, the currents on the line would be precisely the same, both in kind and degree, as the currents in the line of the best form of speaking telephone now known; and precisely the same in kind, but far superior, to the operative currents on the line of the apparatus shown in Bell's patent of 1876. The Reis method is a method of transmitting vocal or other sounds telegraphically by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal or other sounds; and Bell's method is not the first method for transmitting articulate speech telegraphically.

"The transmitter used in the Dolbear telephone is in all material respects identical with the Reis-Wright transmitter. . . . The line is an open circuit, and is the first open circuit ever used for any practical purpose, and it was wholly unknown until Dolbear's discovery that such a line was capable of any practical use. The receiver is wholly new, wholly unlike any prior instrument, and operates upon a principle never before applied in any of the useful arts. . . . Dolbear's method is his own discovery and invention, is radically different from all other methods of transmitting sounds, except as to its first step, which is the same as that of the Reis-Wright method, and is of the highest value and importance, inasmuch as it remedies fully some very serious faults in the Bell method, which was the best known before Dolbear's discovery."

The record contains much more in the same line as what I have quoted, but I need not trespass further upon your space, as it is not my purpose to try to anticipate in your columns the argument of the case, which is to be heard at an early day in the Supreme Court, at Washington.

Very respectfully yours,
HENRY B. METCALF,
President, Dolbear Elec. Telephone Co.
Pawtucket, R. I., Nov. 28, 1885.

THE TELEPHONE QUESTION.

To the Editor of the Scientific American:

I notice a few facts stated by Mr. Berliner in your paper of Dec. 12, to which I take exceptions:

1. Reis accurately and minutely *described* the mechanism of his apparatus. He carefully *described* how to connect up the transmitter "through the battery to the distant station" and back to the transmitter. He explicitly says that *any* sound of sufficient intensity made at the transmitter will be reproduced at the receiver. Therefore I claim that while Reis' theory and explanation of that theory may or may not have been erroneous, *Reis' telephones, when used as described by him, will transmit speech.*

2. He who discovered *the* art, or broad principle, of transmitting speech, as did Reis, is entitled to the fame due to such discovery. He who invents *an* art (meaning thereby "the employment of certain definite means to accomplish some desired end") "is entitled to financial success based upon a patent for such an art." Such an art or method or system was invented by Reis, another by Bell, another by Edison, others by Dolbear, etc., etc. Between the two claimants for such art of transmission of speech in the broad sense, an eminent scientist, who has given great attention to this question, has thus expressed himself:

"Whatever the action may be, no man has a right now to claim exclusive ownership of it for having discovered an explanation of it, even if his explanation should turn out to be more accurate and exact (which need not yet be admitted) than that of the man who first used that action for the transmission of words. If Mr. Bell's explanation proves correct, well and good; he deserves *scientific credit* for it, but not *patent right* in it as against Reis."

3. The Reis transmitter was *automatic* in its action, and hence *always* "beyond his control." The same is true of the Blake transmitter, or of any other, when transmitting compound vibrations, as in speech.

4. The Reis transmitter, when transmitting such compound vibrations, automatically controlled the electric current in accordance with the sound waves which produced them; since Bourseul did not make nor completely describe any apparatus, his invention is limited to theory. It behooves Mr. Berliner, for obvious reasons, to stoutly affirm that when "Reis did occasionally understand spoken words," his transmitter was not acting in accordance with principles "accurately expounded by Charles Bourseul." Reis telephone does not "make and break" (quoting from Bourseul article) "the electric current according to the air vibrations by which it was effected," except in the sense in which it is done in any carbon microphone.

5. Mr. Berliner's fifth "fact" I will leave to the parties who were concerned in Bell's specification and in Gray's caveat at the time they were written, with the remark, however, that the most important claim of the friends of Gray is that Bell changed certain vital words in his specification *after it was "sworn to," and after* seeing Gray's caveat.

6. That we can *now* speak with the Reis instruments is proof that it was physically possible to do so in the time of Reis, a fact that was stoutly denied at one time by some, both as regards transmitter and receiver. And this fact, taken with the quotations from Reis in SCIENTIFIC AMERICAN article of November 28, to the effect that Reis did transmit speech, should be sufficiently conclusive to any one except a stockholder or other interested party of the great telephone ursurpation.

Moreover, the cases of Reis and of Morse are not parallel, for this reason: Reis made and used his apparatus for this specific purpose; if Morse had used his for the same purpose, he would have antedated Reis by twenty-four years in the invention of the speaking telephone, for Reis' system is but Morse's telegraph system operating automatically.

H. C. BUCK.

Boston, Dec. 15, 1885.

OF THE THEORY OF THE ELECTRO-MAGNETIC TELEPHONE TRANSMITTER.

By M. E. MERCADIER.

THE first point to be studied in this theory is the part played by the iron or steel diaphragm of the telephone.

1. From the *elastic* point of view, as regards the nature of the movements which it effects. 2. From the *magnetic* point of view, in the transformation of mechanical energy into magnetic energy resulting from its movements.

1. If there are produced in the air in front of the diaphragm vibratory movements, simple or complex, like those resulting from articulate speech, either the fundamental and harmonic sounds of the diaphragm are not produced, or they play merely a secondary part.

In fact: 1. The diaphragms are never set in vibration, as it is supposed, if we wish to determine the series of the harmonics and of the nodal lines; for they are not left to themselves when they have been set in motion; no free play is given to the action of the elastic forces; in a word, the vibrations effected are constantly forced.

2. If a disk is absolutely set in a groove, when its borders are fixed, theory indicates that the first harmonics of the free disk ought to rise only a little. Let us take disks of steel of 0·10 meter in diameter and only 0·002 meter in thickness, the fundamental sound of which, in the free state, is about ut_4, and which is further raised by framing in. We do not see how this fundamental and the harmonics can be brought into play when there is produced before the disk a continuous series of sounds or of accords of a pitch below ut_4, or when a man, the pitch of whose articulate speech is always in the gamut of index 3, speaks into a diaphragm of this kind. Nevertheless, these sounds and this speech are perfectly reproduced (with a feeble intensity, indeed, in an ordinary telephone), with their pitch and their timbre. They produce, therefore, in the transmitting diaphragm, movements other than those of the fundamental sound and of its particular harmonics.

3. It is true that in practice the edges of the telephonic diaphragm are in no manner fixed, but merely inclosed between pieces of wood or of metal, the mass of which is comparable to their own; they are, therefore, as regards elasticity, in conditions not well determined. Still, a diaphragm of ordinary diameter (from 0·05 to 0·10 meter), and very thin (from 0·25 to 0·5 millimeter in thickness), inclosed in this manner at its edge, is capable of vibrating if a continuous series of sounds is produced near it, by means, for instance, of a series of organ-pipes. But the series of sounds which it distinctly strengthens by manifesting complex nodal lines is visibly *discontinuous;* how, therefore, can its existence suffice to explain the production of a continuous scale of sounds—sound isolated or superimposed—which is the essential property of the telephone?

4. The interposition between the diaphragm and the source of the vibratory movements of a plate of any substance whatever in no wise affects its telephonic qualities, nor, consequently, the nature of the movements, which would be very surprising if it were these which correspond to the particular sounds of the diaphragm. This fact is already known. I have verified it with mica, glass, zinc, copper, cork, cotton, wood, paper, feathers, soft wax, sand, and water, taking certain of these substances even in thicknesses of 0·15 to 0·20 meter.

5. We may put a diaphragm manifestly out of condition to produce its particular scale of harmonic sounds, by loading it with small masses irregularly distributed over its surface, by cutting it in form of a wheel, or of piercing it with holes, so as to deprive it of the half of its mass. None of these modifications destroys its telephonic properties.

6. We may go still further, and employ diaphragms of a rigidity and an elasticity almost *nil*, without affecting the essential telephonic properties, that is, the reproduction of a continuous series of sounds of accords, etc. Such is the case with a diaphragm of sheet iron. It is very difficult, then, to imagine a fundamental sound and its harmonics.

The conclusion of all this seems to me to be that the mechanism in virtue of which telephonic diaphragms execute their movements is at least analogous to, if not identical with that by which solid bodies of any form—a wall, for instance—transmit to one of their surfaces all the vibratory movements, simple or complex, successive or simultaneous, and varying in period in a continuous or discontinuous manner, which are produced in the air in contact with the other surface. In a word, we have here a phenomenon of *resonance.* In diaphragms of a sufficient thickness, this kind of movement would

exist alone; in slender diaphragms the movements corresponding to their particular sounds may be superposed on the former—a superposition more troublesome than useful, for if there results in these cases a strengthening of the effects produced, it is at the expense of the timbre, as the harmonics of the diaphragm can only by the greatest chance coincide with those of the sounds which bring into play the fundamental sound of the diaphragm, as experience distinctly proves.

II. Let us now pass to the magnetic part of the telephonic diaphragm. This part may be clearly defined by the following facts:

1. The presence of the magnetic field does not at all modify the foregoing conclusions.

2. By diminishing more and more the rigidity and elasticity of the diaphragm, I succeeded in suppressing it completely. It is sufficient to substitute for it in any telephone a few grains of iron filings, thrown upon the pole of the magnet, covered with a piece of paper or pasteboard, in order to reproduce, though with a very feeble intensity, all sounds and articulate speech, with its characteristic tone.

3. To augment the intensity of the effect produced, it is sufficient to substitute for the iron diaphragm a slender disk of any substance, slightly flexible, whether metallic or not, *e. g.*, pasteboard, and to spread over it across the opening of the ordinary cover of the instrument 0·1 or 0·2 grm. of iron filings, which marks out in the space the lines of force.

We obtain thus an iron-filings telephone. By suitably increasing the intensity of the magnetic field, I have been able to obtain telephones of this kind, producing in an ordinary recipient effects as intense as the ordinary transmitters with rigid disks, and like them, reversible. For a field of given intensity, there is a weight of filings which produces a maximum effect.

We see thus that the advantage of an iron diaphragm over filings is reduced to presenting in one and the same volume a much more considerable number of magnetic molecules to the action of the field and to external actions. It increases the intensity of telephonic effects; but to produce them with all their variety, their delicacy and their perfection, it is by no means indispensable; it is sufficient to materialize in some manner the lines of force with iron filings, and to act mechanically upon them, and consequently upon the field itself.—*Comptes Rendus.*

THE GLYNDE TELPHER LINE.

THE first industrial telpherage line was inaugurated on the 17th of October at Glynde, a small village in the County of Sussex, for the service of the Sussex Cement Company, at Newhaven. It is to serve for the carriage of the 150 tons of clay per week necessary for the ordinary course of manufacture.

We have no need to describe the system in detail; it will suffice to describe its principle. The idea was first made known by the regretted Fleeming Jenkins, who afterward developed it, in conjunction with Messrs. Ayrton & Perry, without having had the satisfaction of seeing the completion of his work, as he died last June.

Jenkins has defined telpherage as the transmission of vehicles to a distance by electricity, independently of any surveillance and of any control exercised upon them; but, fearing that the not very euphonious name of "telpherage" might in hasty reading become confounded with the word "telephone," he substituted "telpher" (to carry far) for it; and the line upon which the vehicles run is a telpher line.

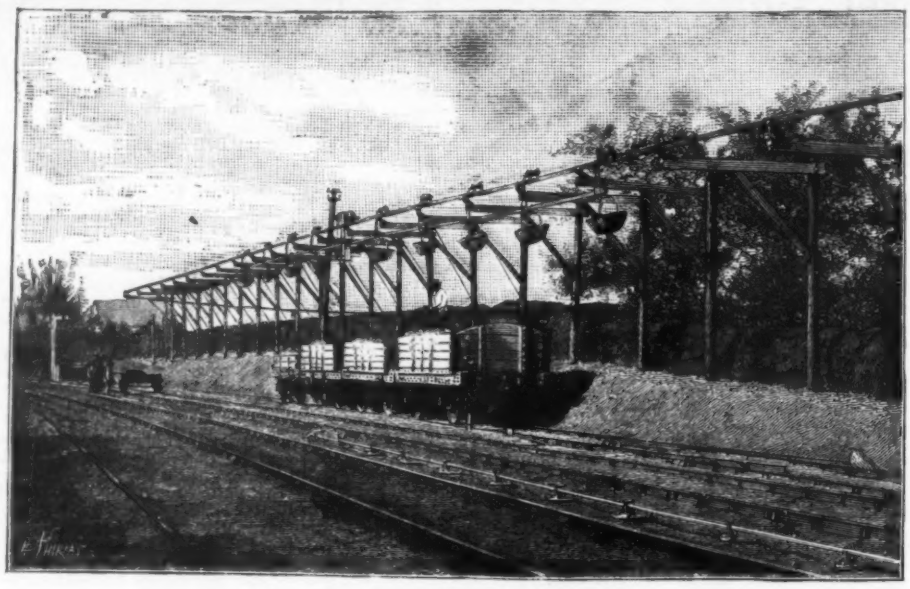


FIG. 1.—THE GLYNDE TELPHER LINE.

At Glynde the telpher line is about one mile long. It consists of a double series of steel arms, 6¼ feet in length by ¾ inch in diameter, supported by a series of wooden poles 18 feet high. At curves the line consists of angle irons placed upon supports 13 feet apart. Motive power is furnished by a Rushton & Proctor engine, the speed of which is kept sensibly constant by a Willans electric regulator. This motor drives a Crampton dynamo, which is excited in derivation and is capable of producing 6,000 watts (8 H. P.) with a difference of potential that never exceeds 200 volts. When the motor is driving a single train and locomotive, the intensity of the current is 8 amperes, but 16 for two trains, and so on, all the locomotives being mounted in

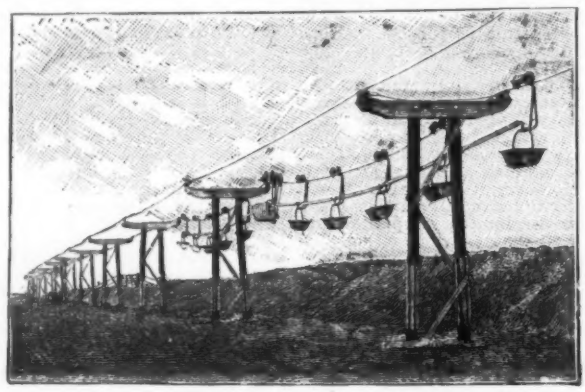


FIG. 2.—GENERAL VIEW OF THE LINE.

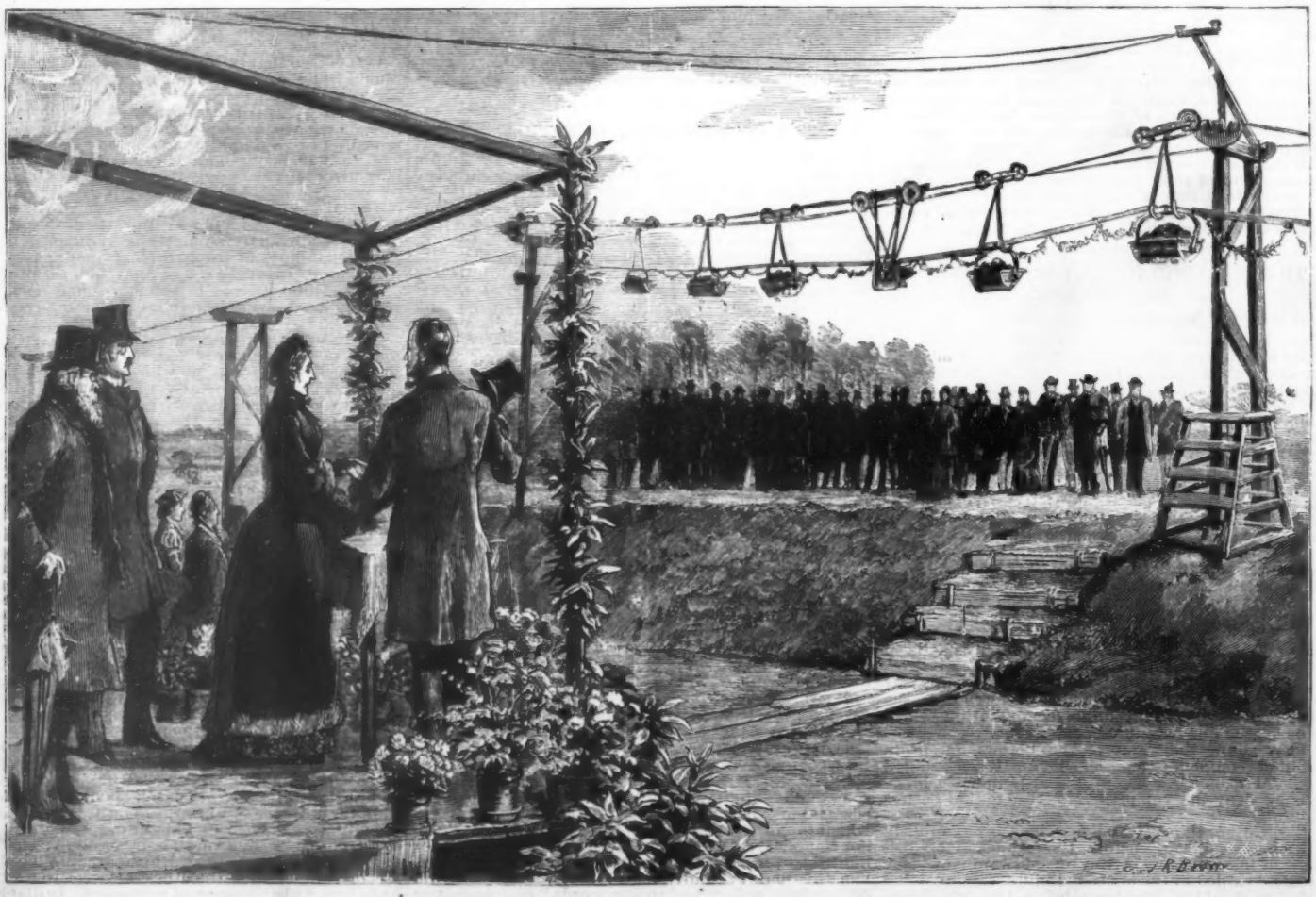


FIG. 3.—OPENING OF THE TELPHER LINE.

derived circuit upon the line. Each train consists of a locomotive provided with a Reckenzaun motor, and from eight to ten cars carrying from 250 to 300 pounds of clay.

When the velocity of the motor gets beyond 2,100 revolutions per minute, the current is abruptly broken, and the current ceases to traverse it until the speed is reduced to 1,900 revolutions. The result of this arrangement is that in up grades, where traction requires considerable work, the current is almost always closed, while in down grades it is, on the contrary, almost always open. A saving is thus obtained in the motive power, and the extra current resulting from the breaking of a single-motor circuit at once is too feeble to interfere with the insulation of the dynamo generator. The resistance of the line is so weak that the velocity of the motors does not sensibly vary, whatever be their distance from the generating machine. The Reckenzaun motor produces at 1,600 revolutions per minute a power of $1\frac{1}{2}$ horse, with a performance of 60 per cent. Its weight is 120 pounds.

The difference of potential of from 180 to 200 volts kept up on the line is sufficient, seeing the shortness of the latter; but in longer lines having a greater traffic the tension might be raised, and reach 2,000 volts. Still, it would not in any case be desirable to extend the distance of carriage beyond five miles on each side of the generator.

Figs. 1 and 2 show the principal arrangements of the telpher line now in operation at Glynde. All sorts of difficulties were purposely accumulated here, in order, through a prolonged experiment, to thoroughly ascertain the merits and defects of the system, as well as the modifications that it would be necessary to make in order to render the operation unexceptionable. Some trials made several weeks previous to the inauguration showed that, as a whole, the system exactly fulfilled all the conditions required.

Without exggerating the importance that telpher lines will be capable of rendering, we may say that they will find an application everywhere where the traffic is sufficient to pay the interest on and liquidate the cost of a narrow gauge road constructed as economically as possible. Over the systems of carriage by cable hitherto proposed or employed, that of electric traction has the advantage that it can be more quickly set up, and is simpler and cheaper. The line requires but little care, there is nothing to be lubricated, and there is no part submitted to friction or griping. The changes in direction or in gradients are less complicated, and the motive power is much less in general, except in the case of a straight road.

Finally, let us add to these advantages another one, and that is at any point along the line there may be obtained a motive power for actuating agricultural or other machines without in any way interfering with the running of the trains. On the day of the inaugution, this application was demonstrated by a root cutter actuated by a small Ayrton & Perry electric motor.

The construction of telpher lines necessitates no viaducts and no purchases of land, and they may be carried over fields without in any way interfering with agricultural operations. Without coming into competition with railroads, they will, on the contrary, come to the latter's aid by supplying them with merchandise that is now carried by trucks or on the backs of animals.—*La Nature.*

[Continued from SUPPLEMENT, No. 522, page 8340.]

THE AMERICAN PUBLIC HEALTH ASSOCIATION.

THE LAMB PRIZE ESSAYS.

IN the evening, the Lamb prizes were awarded as follows:

1. On "Healthy Homes and Foods for the Working Classes." For this thirty-six essays were presented, none of which was deemed worthy of a first prize. The second prize was awarded to Victor C. Vaughan, of Ann Arbor, Mich.

2. On "The Sanitary Condition and Necessities of School Houses and School Life." Hon. Erastus Brooks of New York, in presenting the report of this committee, stated that twenty essays had been submitted. From the study of these essays, the committee found that the writers generally agree in condemning corporal punishment and school competitions; also exhibitions in the heat of summer. Some of the essays mentioned following topics: Out of 2,300 pupils in a school in New York, only 122 had perfect eyesight. If children are forced to go to school, they ought to be taught in regard to the body. What is said of overstudy in school is more of a delusion than of truth.

Diseased pupils should be quarantined. Teachers should be licensed. Co-education of the sexes approved. Swedish movement exercises approved.

The committee recommend the following conclusions: 1. That other knowledge than ordinary lessons is desirable. 2. Good health should be fostered. 3. Greater interest is demanded in school houses and their appointments. Myopia is increasing at an alarming rate. 4. Our ancestors became responsible for the diseases of this generation, and we are so for following generations. No first prize was awarded, but the second prize was bestowed on Dr. D. F. Lincoln, of Boston.

3. On "Disinfection and Individual Prophylaxis against Infectious Disease." Nine essays were submitted. The first prize was awarded to Major George M. Sternberg, honorary fellow of Johns Hopkins University. His essay ably supplements the report of the committee on Disinfectants, of which he is chairman. No second prize was awarded.

4. On "The Preventable Causes of Disease, Injury, and Death in American Manufactories and Workshops, and the Best Means and Appliances for Preventing and Avoiding Them." Three essays were submited. No first prize was awarded, but the second prize went to George H. Ireland of Springfield, Mass.

The first prize was $500; second prizes, $200 each. The money not awarded is retained to be given in similar prizes next year.

ON SCHOOL HYGIENE.

Prof. D. A. Sargent, of Harvard University presented the report of the committee on School Hygiene. The committee thought that course of training should be adopted which actual observation had proved to most thoroughly distribute physical exercise in proper proportion with the mental exercises of education. The youth should also be taught the first laws of the body, the necessity of cleanliness, pure air in houses, etc., and not only taught these principles, but shown how to practically use their knowledge.

ON CREMATION, ETC.

Dr. John Morris of Baltimore presented the report of the committee on Disposal of the Dead. This subject has attracted much attention, and been thoroughly discussed. No doubt the general acceptance of the germ theory, and the surprising discoveries of Pasteur and Darwin concerning the life and office of earth-worms, have materially influenced public thought in this matter. Even those who do not favor cremation admit the necessity of reform in the present mode of burial.

Cremation is gaining ground in Europe. A bill legalizing this process has been introduced in the French Chamber of Deputies, and is supported by such advanced thinkers as Paul Bert and Tony Renelon. It is proposed to build a large crematory near Paris, and an engineer has been sent to Italy to study the best plans. 4,380 bodies are yearly dissected in the Paris colleges. The debris of these are now incinerated in Pere la Chaise cemetery, where three crematories are devoted to this purpose.

Three hundred and ninety-six bodies have been cremated in Italy within the year.

A valuable contribution to the subject of inhumation has been recently made in France by Drs. Au Mesuil and Faurel. The deductions therefrom are that in every cavity dug where organic matters are decomposing, there are produced two phenomena which jeopardize the lives of those exposed to their influence, viz., the great and rapid disengagement of carbonic acid and notable diminution of oxygen in the air.

The Spanish Cortes has passed a bill allowing cremations. The dreadful scenes in Grenada, where hundreds of bodies lay for days uncovered during the late cholera epidemic, no doubt influenced the legislation. Germany is also adopting cremation, and the Berlin *Verein fur Innere Medicin* has declared that the best authorities in the field of hygiene have clearly proved that cremation is the safest preventive against the spread of contagious diseases by corpses. There were 186 cremations in Germany last year. In Denmark the subject is exciting marked attention. At the meeting of the Academy of Medical Sciences, held at Copenhagen in 1884, Dr. Levison presented a report on the cemeteries of Denmark and their influence on the public health. After a most thorough and scientific investigation into the public health of Copenhagen, he concludes that it has been repeatedly demonstrated that pestilential diseases have been traced to the use of water from streams or wells contaminated by the presence of cadaveric decomposition.

In London fifty acres a year are required to bury the dead. Four persons have been cremated in England during the past year, it having been decided to be legal. The Church of England has adopted papier mache coffins, which soon melt away and leave the corpse to be decomposed by the action of the soil, etc.

A cemetery company has lately been formed in England, and purchased 2,000 acres of dry land for a cemetery.

In America there are now three crematories. Thirty corpses have been thus far cremated.

At the St. Louis meeting of this association last year, a member, and an author of a text-book on hygiene, said that no infection was ever traced to a cemetery. But Friere says that Rio cemeteries are nurseries of yellow fever, and Dr. Hunt's report in New Jersey, and Levison's in Denmark, show infection from cemeteries.

An analysis of water near a cemetery in Baltimore shows great impurity.

Other schemes for the disposition of the dead have been urged. Mr. Pratt of London proposes to bury dead paupers in cheap coffins, to be cemented with concrete and used as a breakwater at Heine Bay. Mr. Kergovtatz of Brest proposes rubbing a corpse with a chemical solution and plunging it into a metallic bath, investing it with an air-tight covering. Gold, silver, or copper could be employed, and the dead could thus be utilized as statuary.

After explaining objections to the present mode of burial, Dr. Morris said:

"If incineration were accepted, all these evils would be arrested. It is generally admitted that this process should be adopted in all great epidemics and after battles, but it would be wise to extend it to cases of zymotic diseases, such as small-pox, scarlet fever, and diphtheria. These poisons are preserved for years, and at certain times, under certain conditions, vent their destructive force on the human race."

In discussing the paper, Mr. Rohe admitted he had said there was no trustworthy evidence of contamination from cemeteries. He had not even yet seen any. The wells referred to may have been contaminated in other ways.

In reply to a question, Dr. Morris stated that the expense of cremating a corpse in France is 15 francs.

Dr. Abbott mentioned that in 1877 coroners' juries were abolished in Massachusetts, but 15,000 cases had been investigated under the new system, which worked satisfactorily.

ROUTINE BUSINESS.

Only the morning session was held on Friday. A large amount of routine business was transacted, committees appointed, and resolutions passed.

The report of committee on Disinfection of Rags, appointed yesterday, recommending disinfection at ports of entry by use of superheated steam, was regarded as premature and as made in the interest of Philadelphia health authorities. Hence it was recommitted without adoption.

A CASE OF TYPHOID.

Dr. Lindsley, health officer of New Haven, read a paper describing case of typhoid at Madison, Ct.

A STUDY OF SOUTHERN WATER.

Dr. Thomas F. Wood, Secretary of the State Board of Health of North Carolina, read a paper on "Observation of the Cape Fear River Water as a Source of Water Supply; a Study into the Character of Southern River Water." This water has long been valued by sailors on account of its keeping qualities, which are due to vegetable infusion, derived from pine cypress, etc. The water has a yellowish hue. Filtration does not discolor it, but alum and lime do.

In the distinctive distillation of this water for the purpose of manufacturing ice, it was found that creosote was developed. Hence the process had to be abandoned. The temperature of the running water, rising sometimes as high as 86° F., shows the decomposition of organic matter to be in progress.

HYGIENE OF THE DWELLING.

Mr. George N. Bell's paper on "Hygiene of the Dwelling," read by Dr. A. N. Bell of New York, explained the deleterious effects of keeping dwellings closed during a large part of the year, as exhibited at Newport.

ANIMAL DISEASES AND FOODS.

The report of the committee on Animal Diseases and Animal Foods, by J. M. Partridge of South Bend, Indiana, chairman, was then presented. Epizootic diseases are known to have prevailed during the last 4,000 years, having been mentioned by Moses and known among the Aryans. Virgil also refers to them.

The importation of cattle has brought a pestilence to this country.

Trichinæ have prevailed somewhat during the year; also swine plague, or hog cholera. The diseased animals should be quarantined.

Several other diseases were mentioned: not more than one-quarter of the producing capacity of the country has been utilized.

The establishment of a veterinary school was recommended.

MORE LAMB PRIZES.

It was announced that Mr. Lamb had contributed funds for four additional prizes of $100, $75, $50, and $25 for the best plans of houses to cost $600, $1,000, and $1,500.

ELECTION OF OFFICERS.

The following officers were elected: President Dr. Henry P. Walcott of Cambridge, Mass.; first Vice-President, Dr. C. W. Covington of Canada; second Vice-President, Dr. G. B. Thorton of Memphis, Tenn.; Treasurer, Dr. J. Berrien Lindsley of Nashville, Tenn.; Executive Committee: Dr. Pinckney Thompson, Kentucky; Dr. Henry B. Baker, Lansing, Mich.; Dr. Joseph Holt, New Orleans, La.; Dr. Charles Smart, U. S. A.; Dr. C. N. Hewitt, Minn.; and Dr. H. A. Johnson, Chicago, Ill. The Secretary, Dr. Irving A. Watson of Concord, N. H., holds over.

THE NEXT MEETING.

The next meeting will be held at Toronto, Ont., at a time yet to be decided, probably next October. Dr. P. H. Boyce was appointed chairman of the local committee, with power to appoint other members.

An urgent invitation was received from Memphis, Tenn., and it is believed that the meeting in 1887 will be held there.

NOTES.

A noteworthy circumstance connected with the visit of the Association to President Cleveland at the White House was the fact that the procession was immediately preceded by a funeral with *two* hearses.

The concluding exercise of the Association was one of those oyster bakes for which Washington is so famed, at the Eleventh Street wharf, whereat the sanitary legion received numerous accessions, and practical sanitation was exemplified.

UNILATERAL HALLUCINATIONS.*

By WILLIAM A. HAMMOND, M.D., LL.D.

THE fact that hallucinations of sight and of hearing may be unilateral—that is, perceived by one visual or auditory center only—has long been known, though the subject has not even at this day attracted so great a degree of attention as it appears to me to require. Several writers have, however, considered the matter from a more or less philosophical standpoint, and have brought forward interesting cases in support of the views to which they have given their adhesion.

The first reference to the fact that hallucinations may be one-sided that has come under notice is made by Calmet,† who describes the fright experienced by a gentleman who, passing some time in a haunted house, heard a voice in one ear—the left—which came from a corner of a closet, and seemed to him to be about a foot above his head. This voice spoke to him very distinctly during the space of half a *miserere*, and ordered him, *theeing* and *thouing* him, to do some one particular thing, which he was recommended to keep secret.

Calmeil‡ alludes to the fact that some persons, the subjects of hallucinations of hearing, declare that the sounds are heard first in one ear, and then in the other, or exclusively in the right or left ear.

Baillarger§ cites two cases of hallucinations of hearing occurring in but one ear. In the first of these, a woman, who was under the delusion that she was being taken to a cemetery, imagined that she heard a mysterious voice encouraging her, and telling her not to be afraid. In the other, a woman, affected with religious monomania, perceived in the right ear the sound of celestial music, which caused in her the highest degree of mental exaltation. Baillarger does not refer to one-sided visual hallucinations.

Michéa,‖ who had previously written an excellent monograph¶ on hallucinations, in which, however, he did not consider those of a unilateral character, refers to them specifically in his subsequent work, and attempts an explanation of their *rationale*. He says:

"In the fantastic or subjective perception which constitutes the phenomena of hallucination, the mind experiences a modification identical with that which takes place in the normal or objective perception. The false representation, the deceitful appearance, of which he has conscience, seems to it to be the result only of an exterior impression produced simultaneously on the two symmetrical or homologous portions of a sensorial

* Read before the New York Neurological Society, December 1, 1885.

† "The Phantom World," etc., Augustin Calmet. Edited by Mr. Henry Christmas. London, 1850, t. ii., p. 291.

‡ Art. "Hallucination" in "Dict. de medecine."

§ "Des hallucinations," etc., "Memoires de l'academie royale de medecine," t. xii., pp. 295 and 300.

‖ "Du delire des sensations," Paris, 1851, p. 106.

¶ "Des hallucinations," etc., "Mem. de l'acad. royale de med.," t. xii.

apparatus. The attention is directed to the imaginary body, and not to the instruments by which the impression is produced. The mind interprets as single the double action of the sensorial organs that receive and transmit the impression of the fantastic image, and by which it is brought to the consciousness and understanding. Nevertheless, it is not always thus. In certain cases the mind can be affected in such a manner that it perceives an imaginary object in the same way that it perceives a real body, the impression of which is effected on one alone of its two symmetrical and homologous portions; in a word, although always the same so far as regards characteristics and form, a hallucination may sometimes lose its unity of correspondence and be doubled and dichotomized, so to speak, relative to one single sensorial apparatus."

In accordance with this view, Michea gave to the erroneous perceptions in question the designation of *dicided hallucinations.*

Schroeder van der Kolk* cites a case, the only one, as he says, within his experience, in which the hallucination occurred in one ear. A poor woman complained to him that she was continually persecuted by the devil, who let loose at her all sorts of blasphemies, and indeed all the worse the more she exerted herself not to attend to them, but often also when she was talking and active. She had already been to a clergyman to have him exorcise the devil before she came under Schroeder van der Kolk's observation. On his asking her in which ear the devil always talked to her, she replied that it was invariably the left ear. He told her that her disorder was due to an affection of the ear that sometimes occurred.

Dr. Alexander Robertson,† in an interesting monograph, cites several cases of unilateral hallucinations occurring especially with the subjects of alcoholism. According to him, they are more frequent on the left than on the right side. He regards them as being the result of an independent action of the two hemispheres.

Dr. E. Regis‡ enters at some length into the history of the subject, and adduces several cases in support of the view that unilateral hallucinations are always due to some derangement of the sensorial apparatus—the eye or the ear—on one side. His attention was first attracted to the subject by the case of a patient who heard himself abused in opprobrious terms, but only in the right ear. He was able to induce these hallucinations at will by closing the left ear and concentrating his attention on some particular idea, when very soon this idea would be expressed vocally to him in the right ear. This patient had been affected since he was twelve years old with a purulent otorrhœa, localized in the right ear, due to chronic catarrh of the cavity of the tympanum. A case cited by Pick sustained his view, and the others occurred in his own experience, both as regarded the eye and ear.

An exceedingly interesting form of unilateral hallucinations is that in which erroneous impressions different in character occur on either side. M. Magnan,§ at the meeting of the Medical Congress in Rouen in 1883, read a paper on this form of the affection, the patients having had hallucinations in both ears, occurring simultaneously, but opposed to each other in the nature of the impressions communicated. One patient heard through one ear—always the same—threats and abusive language, which gave him ideas of persecution, while through the other ear the perception was of flattering words, and others of a character calculated to excite in him ambitious delirium; and this antagonism of sensorial auditory impressions was maintained without change during the whole course of his disease. M. Magnan reported four cases of the kind occurring in his own experience. In one the painful impressions came through the right ear, while the pleasant ones were produced on the left side. In the three others this relation was reversed. He regards these cases as affording a new proof of the functional independence of the two cerebral hemispheres, and as presenting a great analogy with the facts obtained by experimentation with certain hysterical subjects.

Of course, as is well known, the sense of touch can be the seat of unilateral hallucinations just as it is readily and normally affected by actual impressions. So far as concerns the present subject of inquiry, such derangements are of no moment, as they originate ordinarily from subjective irritations. Sometimes, however, especially in hysterical and hypnotized persons, they may have central origin. M. Dumont-Pallier‖ had a patient in La Pitie whom he hypnotized, and in whom he could determine at will anæsthesia, hyperæsthesia, or sensorial delirium alternately in one-half of the body and the other. One of the cerebral hemispheres, it is stated, appeared to preserve its power to act, while the other was deprived of all activity. By other experimental combinations he could bring the two hemispheres into simultaneous action, but in an opposite way. Thus, the patient being in the unconsciousness of hypnotism, he could, by whispering in one ear words conveying sad ideas, give to one half of the countenance the expression of pain, while, by suggesting cheerful words in the other ear, the corresponding side of the face showed satisfaction.

I have given this short *resume* of the subject mainly for the purpose of showing the state of the inquiry at this time, and not with the idea of submitting anything like a complete history of the researches and observations made. In the next place I have to bring forward my own cases, and to make such remarks upon them as they may appear to require.

So far as I am aware, no case of unilateral illusions has yet been reported. One case of the kind has come under my notice, and, though the subject of illusions is not under direct consideration, its relations with the present inquiry are so intimate that it seems proper to refer to it here with somewhat more of amplitude than I gave to it when I first brought it forward,¶ nearly three years ago:

CASE I.—A gentleman, in good general health, contracted the illusion that the ticking of a clock on the mantel piece consisted of articulate words. At first he only had this erroneous perception at night after he went to bed, but in a few weeks the ticking of any clock sounded to him like human speech. There was no uniformity either of the tone or of the language employed, but sometimes a particular phrase would be repeated hundreds of times. As soon as he got beyond the range of the sound from the clock, the words were no longer heard.

Generally, the expressions were in the form of commands. For instance, if at dinner, they would be "Eat no soup," "Drink no wine," or "Eat your soup," "Drink some wine," and so on. One day he made the discovery that if he closed the right ear firmly the illusion disappeared, but, if the left ear was closed, the words were still distinctly heard. It was, hence, clear that the center for hearing on the right side was the one affected, and that that on the left side was normal. On neither side was there the slightest impairment of the capacity for hearing other words. A watch would be readily heard to tick at the distance of three feet from either ear.

These false impressions were not by any means unpleasant to him; on the contrary, he was rather inclined to attend to them, and to amuse himself with suggesting new phrases for the clock to simulate. He did not allow himself to be deceived with the idea of regarding them as realities, but, though he strenuously resisted their acceptance, he began, after a time, to be influenced by them to the extent of acting upon them as guides, though he tried to conceal the circumstance. When, for instance, asked whether or not he was going to the theater that evening, he would reply in a nonchalant way to the effect that he had not thought about the matter; and then, after a little while, when he thought the matter forgotten, he would saunter toward where the clock stood, and shortly afterward give his answer either affirmatively or negatively, according to the words conveyed to him by the clock. Eventually he put clocks into every room in his house, and proposed to be governed altogether by the directions they gave him, not, as he said, from any belief that the ticks were real words, but because there was some influence, spiritual or other, that caused them to seem like words to him.

During the whole time that this case was under notice there was no change in the unilateral character of the illusion nor in its distinctness. At this time the condition remains unaltered. The sounds made by the clock have all the appearance of words spoken into the right ear, while to the left ear they possess only their normal characteristics. Yet, though he is guided by them, he does not for a moment regard them as words. His intellect is free from any delusion of fact, though he is superstitious enough to accept them as conveying to him indications as to how he should act.

CASE II.—This case is also referred to in my "Treatise on Insanity." A young lady of good mental development but of delicate physical organization was for several months almost constantly troubled with apparitions of various kinds of faces, which she saw no matter where she turned her eyes. She had, while looking through her father's library a few weeks before they first appeared, come across a book containing many engravings of Greek and Roman masks, and these had made a great impression upon her. The pale faces beset her on all sides. Sometimes they would peep at her from around the corners of the streets as she was driving or walking. Again she would see them coming out of the shelves in the shops she visited, and again they would start up from the street just before her. They never passed out of her range of vision suddenly, but gradually faded away without changing their positions. Some of them she saw with one eye and some with the other, for if she shut either eye they decreased in number, about half of them disappearing; and if she closed both eyes, they all vanished for a little while, though generally in either case they reappeared in a short time, but less distinctly. On opening the eyes, a new set appeared. They were of all colors and nationalities, and a good many were of the same description as the masks of the ancients, being of various degrees and character of grotesqueness and hideousness. She never saw them after dark except in well-lighted rooms or other places. The gaslight of the streets was not sufficient to develop them, but the electric light brought them out very distinctly. By repeating the experiment of Sir David Brewster—pressing on the outside of the globe of either eye so as to produce temporary strabismus—she could make any face appear double; but this was only when it had been visible for several minutes. A newly appearing one she could not duplicate in this way. There was no derangement of the vision of any other kind, and no abnormal ophthalmological appearances.

The peculiar features of this case are that the hallucinatory images were divided between the two eyes, part being seen with one and part with the other, showing, therefore, the distinctness and divisibility of the action of the two visual centers, and the fact that the stimulus of a strong light was necessary in order that they should be developed. The circumstance that by pressing on one eyeball so as to throw it out of its parallelism with the other any image was duplicated showed the permanence of the impressions made upon the retinæ—impressions that must necessarily have been transmitted from within and projected outward.

CASE III.—A young man received a severe blow on the head just above the left ear. A few weeks subsequently—while engaged at his business, that of a salesman in a large mercantile establishment—he saw a large black cat sitting on the floor immediately before him. He had no doubt of the reality of the occurrence, and for several minutes wondered where the animal could have come from. At last he made a step toward where the cat was apparently sitting, and was surprised to find that the image remained as far from him as before. He then recognized the fact of the falsity of the perception. After this the cat seemed to follow him wherever he went, and sometimes appeared to jump on his lap or shoulder. His sense of touch was never deceived.

Being possessed of a considerable degree of intelligence, he had, by observation and experiment, settled several interesting points to his satisfaction. Thus, he found that the image was always larger and more distinct in the evening than soon after getting out of bed in the morning. Occasionally at this latter time it was entirely absent, but not often. Again, it was always clearer, larger, and apparently nearer to him when he suffered from pain at the seat of the injury, as he did in paroxysms several times a day. When he was free from pain, the image disappeared when he shut his eyes; but when the paroxysms were present, he saw it just as well when his eyes were closed as when they were open. Pressing on either eyeball so as to destroy the parallelism of the visual axes did not cause the production of two images, and then he made the discovery, by alternately shutting the eyes, that the hallucination only existed on the side corresponding to that on which he had been injured.

In this case there were no abnormal ophthalmological appearances, nor any impairment in the faculty of vision in either eye. That there was serious brain lesion involving, probably, the left optic thalamus, I have no doubt. I was also of the opinion that there had been a fracture of the inner table of the skull at the point at which the blow had been received, and proposed trephining. He, however, declined to submit to the operation, and I finally lost sight of him.

CASE IV.—A lady about fifty years of age became the subject of a most malignant persecution through anonymous letters, which were sent to her in large number and from various parts of the country. The outrage had gone on, however, for several weeks before there was any other result than intense annoyance. But she finally began to worry greatly in regard to the source of the abusive communications, endeavoring to represent to her mind the man or woman guilty of the indecencies of which she was the victim. In this she was not successful. In fact, she could not determine whether the sender was a man or a woman, much less bring before her mind's eye his or her image. One day, however, as she lay in bed with a sick headache, her mind reverted to the question that had so often disturbed her—"Who was the person that sent her the anonymous letters?" Happening to look in the direction of the large bay window that filled up nearly the whole front of the room, she saw a man and a woman standing in the opening.

For the moment she did not doubt the reality of the appearances; but as she raised herself in bed to look at them better, she was astounded to perceive that they slowly faded out of sight, dissolved, as it were, so gradually that they scarcely seemed to get less distinct. She got up, dressed herself, and did not see the images again for several days.

But at last they made their appearance (this time while she was at the dinner table), and presenting exactly the same aspect in every respect as they had at first. After that she saw them several times in the course of a month, and then they disappeared, never to return again.

The most curious circumstance about the hallucination was that the man was perceived with the right and the woman with the left eye. Thus, if she closed the right eye, she only saw the woman; and if she shut the left eye, the man only was visible. If she had, by moving actively about the room, caused them to disappear, she could often bring them back by lying down on a bed with her head rather low. If, on these occasions, she kept the right eye closed, it was the woman only that appeared; and if she opened only the left eye, she saw but the one image, that of the man. Again, if she had in this manner brought back one image, and then endeavored, by opening the other eye, to cause the other one to appear, it was several minutes, generally, before she succeeded, and thus for a time only one image was present.

Nothing, it appears to me, could be more confirmatory of the case of the independent action of the two visual centers than such hallucinations.

And, indeed, it appears to me that unilateral false perceptions of the kind in question afford strong evidence of the correctness of the theory originally proposed by Wigan,* but since his time adopted by many others, that there are in fact two brains, the two hemispheres having independent though similar functions, ordinarily acting together, though capable of isolated and even different action. Wigan had no facts of this character to allege in favor of his theory of the duality of the mind, for which, nevertheless, he has adduced many striking proofs and convincing arguments, and toward the truth of which science seems to be tending.

Regis, in the memoir to which I have previously referred, advances the opinion, in which he is apparently borne out by the cases he has adduced, that unilateral hallucinations are due to disease or derangement of the organ of special sense involved. That this is not always the case I am very sure. In none of the instances I have cited was there any ocular or auditory trouble. It is difficult to see what connection can exist between disease of the eye or ear and a hallucination existing in the corresponding side. For, if such disease caused a unilateral hallucination, we should expect bilateral hallucinations to be the result of disease of both eyes or ears.

I do not believe that hallucinations are caused by lesions of the organs of special sense, but that they are produced by disease or disorder of the central organ of perception, probably of the optic thalamus, and that such erroneous sensorial impressions, when limited to one side are evidence that the visual, auditory, or other sensorial center, as the case may be, of the corresponding side is the starting point.—*N. Y. Med. Jour.*

UINTAHITE ASPHALTUM.

By Prof. W. P. BLAKE.

IN the month of September last, a sample of a peculiar asphalt was received for examination, and recently when in Provo, Utah, I had the opportunity of seeing a considerable quantity brought in from the Uintah Mountains.

It is obtained in masses several inches in diameter, and apparently free from mechanically disseminated impurities. It breaks with a conchoidal fracture, is very brittle, and is readily reduced to powder in a mortar. Hardness, 2 to 25. Gravity, 1·065 to 1·070. Color, black, brilliant, and lustrous; streak and powder, a rich brown. It is a non-conductor of electricity, and is electrically excited by friction.

It fuses easily in the flame of a candle and burns with a brilliant flame, much like sealing-wax; and like sealing-wax, it will give a clean, sharp impression from a seal. Unless the melted mineral is very hot, it does not adhere to cold paper. It has considerable plasticity while warm, and is not sticky, but retains after melting its lustrous black and smooth surface. By

* "Pathologie und Therapie der Geisteskrankheiten," Braunschweig, 1863, p. 157, note.

† "British Medical Journal," 1875, vol. ii., p. 274.

‡ "Des hallucinations unilaterales," "L'Encephale," t. i., 1881, p. 43.

§ "Annales medico-psychologiques," November, 1883, p. 356.

‖ Cited from "L'Union medicale" in "Annales medico psychologiques," November, 1883, p. 357.

¶ "A Treatise on Insanity in its Medical Relations," New York, 1883, p. 397.

* "The Duality of the Mind," London, 1844.

distillation, a very small quantity of a clear white and dense oil is given off, and a little gas or vapor.

It is much more readily dissolved by the heavy oils and fats than by the lighter and more volatile menstrua. Thus, it dissolves and incorporates quickly in heavy lubricating petroleum, while the white distillates from petroleum have little or no effect upon it at ordinary temperatures. So, also, it freely dissolves in oil of turpentine when warmed, but it does not readily dissolve in cold spirits of turpentine. Ether apparently does not attack fragments, but the powder is slowly dissolved. It is not soluble in ordinary alcohol.

The mineral dissolves quickly in melted wax, and incorporates with it, producing on cooling a hard, black mixture, which closely resembles "burnt wax," and may be used for similar purposes. The mixture also closely resembles the Utah mineral wax or ozokerite. The mineral will also freely melt and combine with ozokerite. It dissolves in hot stearine and melted tallow, giving black mixtures varying in hardness with the amount of uintahite used.

It differs from grahamite and albertite by its easy fusibility and other characters; from piauzite by its gravity, structure, and deportment with alcohol; and from wolongonzite by its fusibility and small amount of oil and gas.

It is said to occur in considerable quantities, and it will no doubt find many useful applications in the arts as a pigment, insulator, and ingredient in lubricating cereous and fatty mixtures.—*Eng. and Min. Jour.*

A COMMON EDIBLE FUNGUS.

AGARICUS (LEPIOTA) PROCERUS, *Scopoli.*—Agaricus procerus is one of the commonest and one of the most delicious, if not the most delicious, of all edible fungi. It also possesses the great advantage of being very easily recognized. With the assistance of the following notes, it should be impossible for any moderately observant person to mistake any other fungus for the grand procerus.

As far as I know, no one has ever said a word of disparagement about the fungus before us. Every one who has written about it or tasted it has had good words for it. It is esteemed by many as better than the

FIG. 1.—AGARICUS PROCERUS, THE TALL OR PARASOL AGARIC.

pasture mushroom itself, for Agaricus procerus, while possessing all the good qualities of the latter, is much more delicate in flavor. Mrs. Hussey says it is the "King of Mushrooms," but to some people, including the writer, this would be but a dubious compliment. The Rev. M. J. Berkeley, who has always been reticent in recommending fungi as food, has been "conquered" by procerus, for he says it is "a most excellent mushroom, of a delicate flavor," and "it must be considered a most useful species." Dr. Badham writes: "Were its excellent qualities better known here, they could not fail to secure it a general reception into our best kitchens, and a frequent place among our side dishes at table." Dr. H. Wharton, M.A., who is certainly no enthusiast for fungi as food, is obliged to write: "Procerus is indeed delicious, soft, savory. Its close ally, rachodes, I have found quite as dainty." We often find our poor relations "quite as dainty" as ourselves, sometimes more so. Fries writes: "Edulis sed lentus." Roques writes:

"Il est peu de champignons, aussi légères, aussi délicates, aussi faciles à digérer. Il a peu de chair, mais il est tres savoureux, d'une odeur douce et fine. Son usage est tres repandu. Plus d'un menage champêtre et fait presque sa nourriture pendant plusieurs semaines."

And Paulet says:

"Elle est d'une saveur tres agreable et d'une chair tendre, tres délicate et tres bonne à manger. Les amateurs la preferent même au champignon de couche comme ayant une chair plus fine et etant beaucoup plus legere sur l'estomac."

After these notes of introduction and admiration, Agaricus procerus may be briefly described. The illustration (Fig. 1), engraved from nature, shows a group of three examples growing in an *open place* among low-growing flowering plants. To make out the botanical characters of A. procerus, it is necessary to get a good fresh example, and cut it in two across the top and down the stem, as was done with A. rubescens. The accompanying outline (Fig. 2) shows the section of a large example of A. procerus. The salient characters given below are printed in italics. A. procerus *grows in pastures*, orchards, lowlands, on banks, and in *open places*, among bracken, etc. *It does not grow in woods.* Observe that the cap is *fleshy*, as shown by the thickness at A; that it is *umbonate*, *i. e.*, it has a boss or swelling in the middle, like the boss of a Greek shield, at B; that the *scales*, C, at length *separate* from the flesh, as at D, E, F (in A. rubescens they are adherent). The stem is piped or hollow, G and H; and it is bulbous, J. There is a ring or collar around the stem, K; it is not permanently fixed to the stem (as in A. rubescens), but is *loose*, L; and when the fungus is mature, the ring may be easily pushed up and down the stem with the fingers. Sometimes the ring breaks and falls away from the fungus to the ground. The *gills do not touch the stem*, but are *remote from it*, M, M. In this species the cap is very readily detached from the stem; the stem may be readily pulled away without breaking the cap, and a depression is then left under the umbo or boss of the cap on the dotted line, N.

This section is a good example of the *line of the hymenophorum* (hymen, or fruit-bearer), O being distinct from the line of the stem, P—a most important

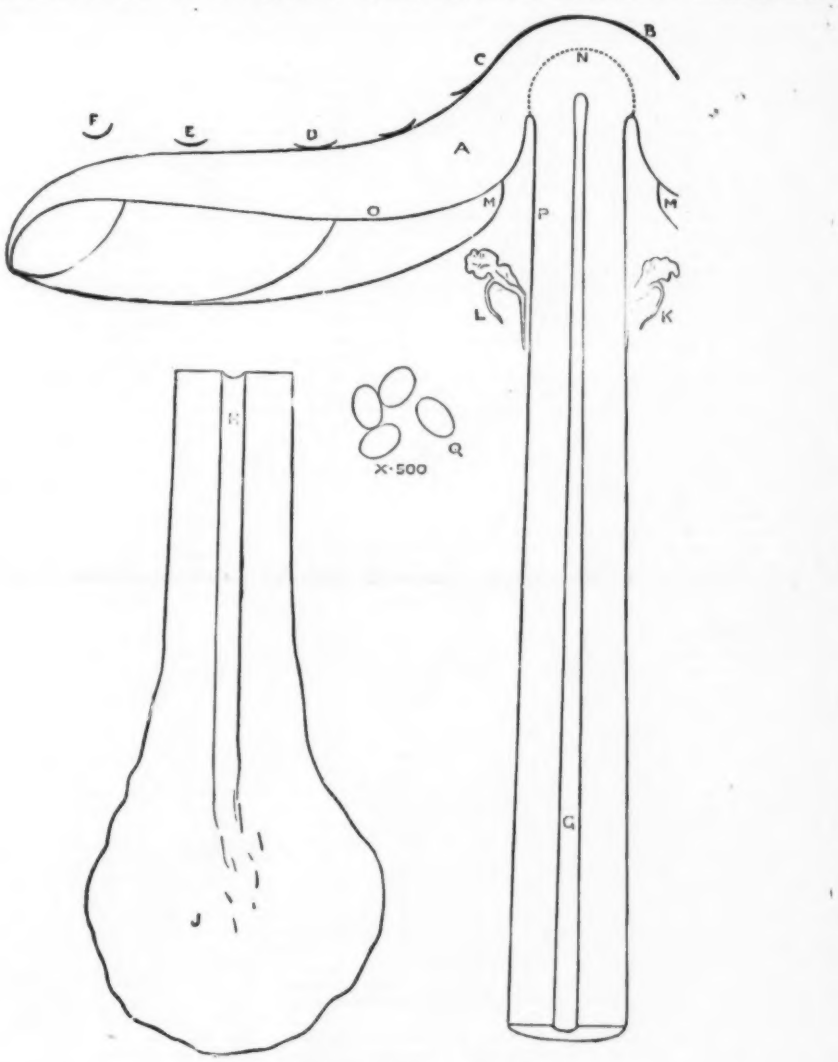


FIG. 2.—SECTION OF AGARICUS PROCERUS.

character, but in some examples unfortunately more potential than definite. The spores or seeds are white; a group of four, enlarged 500 diameters, is shown at Q. The fungus may be popularly described as follows: The cap (pileus) is dry, fleshy, and soft, three to seven inches or more in diameter; in young unexpanded examples the cap is ovate (see illustration), then expanded and umbonate; at first brown in color. Cuticle of cap thin, entire over the center umbo; torn toward the margin into broad, brown (at length evanescent and separating) scales or flakes. Margin and outer surface beneath the scales rough, white, pale buff, or pinkish in color. Gills and spores white. Stem hollow, tall, six to ten or more inches high, half an inch or more thick at top, variegated with small close-pressed brown scales (like the skin of a snake), bulbous at the base. Ring at length loose on the stem. Gills remote or unconnected with the stem. Taste and odor when raw, pleasant.

The sub-genus of Agarics to which A. procerus belongs is named Lepiota, from $\lambda\epsilon\pi\iota\varsigma$ = a scale, in reference to the scaly top; procerus simply means tall, a somewhat indefinite name, as many fungi are tall, and many others are considered by some as scaly things.

Agaricus procerus is really a very close relation of the common pasture mushroom, although it is (artificially) far removed from it in our floras. The chief distinguishing characters are the white gills and white spores of the former, and the purple-brown gills and spores of the latter. There are many species of Lepiota allied to the plant before us, and I should be inclined to trust several of the larger species as edible. The first four species of Fries, viz., A. procerus, A. rachodes, A. excoriatus, and A. gracilentus, I believe, are the same thing. They are gradually run into each other, and it is often impossible for the most acute observer to distinguish one from the other. A. rachodes has sometimes been termed unwholesome, and A. excoriatus (perhaps from some misunderstanding of the meaning of the somewhat threatening specific name) has been called poisonous; but all four are very good for the table, A. procerus being the chief dainty. Some of the larger species, beginning with A. acute squamosus, are perhaps best avoided. One small species, A. cristatus, is known by its disgusting odor. Several grow in greenhouses, and are no doubt of exotic origin, as Sowerby's A. cepæstipes and my Georginæ. Dr. Cooke, in the new edition of his *Handbook*, now in course of publication, says the latter species was named by me "in honor of Mrs. Worthington G. Smith." This unfortunate mistake of the Doctor's might have led (in some quarters) to a domestic altercation: Georgina is some one else!

The proof of procerus is in the eating. Like all other mushrooms, it requires to be well and skillfully cooked, and served quite hot. Sound examples only must be prepared for the table.

The late Dr. Bull, of Hereford, carefully wrote out, from experience, the best modes of cooking A. procerus, and for the following methods fungologists are chiefly indebted to him. The modes are approved by the writer, and are adopted by the Woolhope and other clubs:

MODES OF COOKING AGARICUS PROCERUS.

It may be cooked in any way, and is excellent in all.

Broiled.—Remove the scales and stalks from the Agarics, and broil lightly over a clear fire on both sides for a few minutes; arrange them in a dish over fresh made, well-divided toast; sprinkle with pepper and salt, and put a small piece of butter on each; set before a brisk fire to melt the butter, and serve up quickly.

If the cottager would toast his bacon over the broiled mushrooms, the butter would be saved.

Baked.—Remove the scales and stalks from the Agarics, and place them in layers in a dish; put a little butter on each, and season with pepper and salt. Cover lightly, and bake for twenty minutes or half an hour, according to the number placed in the dish. Put them on hot toast in a hot dish. Pour the hot sauce on them, and serve up quickly.

Stewed.—Remove the scales and stalks from the freshly gathered Agarics, and stew them for twenty minutes in milk and water, which will be improved by a little good gravy; then season with pepper and salt, and add a blade of mace if desired. Thicken the same with a spoonful of flour, a little cream, or the yolk of an egg. Boil for a few minutes, and serve up quickly in a hot, well-covered dish.

Delicately Stewed.—Remove the stalks and scales from the young, half-grown Agarics, and throw each one as you do so into a basin of fresh water slightly acidulated with the juice of a lemon or a little good vinegar. When all are prepared, remove them from the water, and put them into a stewpan with a very small piece of fresh butter. Sprinkle with white pepper and salt, and add a little lemon juice. Cover up closely, and stew for half an hour. Then add a spoonful of flour, with sufficient cream, or cream and milk, until the whole has the thickness of cream. Season to taste, and stew again gently until the Agarics are perfectly

tender. Remove all the butter from the surface, and serve in a hot dish, garnished with slices of lemon.

A little mace, nutmeg, or ketchup may be added; but there are those who think the spice spoils the mushroom flavor.

Procerus Sauce.—Chop up about half a pint of young Agarics, pepper and salt, and add an ounce of butter rolled in flour. Put in a stew-pan over a slow fire for a few minutes; add half a pint of milk or, better still, cream, and boil gently, stirring all the time until it is sufficiently thick and smooth. Pour round boiled fowls or rabbits, or any light *fricassee*.

Beef or veal stock may be used when a brown sauce is required; and some will think a little mace or nutmeg, or a few drops of Indian soy, or a little Harvey sauce, a good addition. The brown sauce is excellent for steaks, cutlets, game, or any kind of *ragouts*.

Scalloped Procerus.—Mince young, fresh Agarics, season with pepper, salt, and a little lemon juice, add a little butter, and stew in a warm oven for ten minutes, then put them in a scallop tin, layer by layer, with fresh bread crumbs, moistened with milk, cream, or good gravy; bake for five minutes, and brown well before a quick fire.

Cottagers' Procerus Pie.—Cut fresh Agarics in small pieces, and cover the bottom of a pie-dish. Pepper, salt, and place on them small shreds of fresh bacon, then put a layer of mashed potatoes, and so fill the dish layer by layer, with a cover of mashed potatoes for the crust. Bake well for half an hour, and brown before a quick fire.

Procerus Omelette.—Mince some young, fresh Agarics; season with pepper and salt; add butter, and set them in the oven while you whisk well the whites and yolks of half a dozen eggs; then put 2 oz. of butter into the frying-pan, and heat until it begins to brown; having again well whisked up the eggs with three tablespoonfuls of the prepared Agarics and a little milk, pour it lightly into the boiling butter; stir one way, and fry on one side only for five or six minutes; drain it from the fat; roll it up, and serve quickly on a hot, well-covered dish.

Potted Procerus.—Remove the scales and stalks from young, fresh Agarics; sprinkle with pepper and salt, and set aside for three or four hours; then place them in the stew-pan with the liquor that will have exuded, and stew until dry; next fry in butter for a few minutes; put them into small jars, and when cold pour in as much butter, melted, as will just cover them; when again cold, pour on a little melted suet, and tie down with bladder.

When required for use, soak them for two or three hours in a little warm milk and water, and stew with milk or cream, or stock, and use it in any way that may be required.

Essence of Procerus.—Sprinkle young but full grown Agarics with salt, and let them stand for six hours. Then beat them well up, and the next day strain off the liquor, and boil very slowly until it is reduced to one-half the quantity.

This essence will not keep long, but is much preferable to ketchup, where the delicate flavor of the Agaric is overpowered by spice. Add to it one-eighth part of good French brandy or half its quantity of any wine, bottle carefully, and it will keep for any reasonable time.

Procerus Ketchup.—Place the Agarics of as large a size as you can procure, but which are not worm-eaten, layer by layer in a deep pan, sprinkling each layer as it is put in with a little salt. The next day stir them well up several times, so as to mash and abstract their juice. On the third day strain off the liquor, measure, and boil for ten minutes, and then to every pint of the liquor add half an ounce of black pepper, a quarter of an ounce of bruised ginger root, a blade of mace, a clove or two, and teaspoonful of mustard seed. Boil again for half an hour, put in two or three bay leaves, and set aside till quite cold. Pass through a strainer, and bottle; cork well, and dip the ends in resin. A very little Chili vinegar is an improvement, and some add a glass of port wine or strong ale to every bottle.

Care should be taken that the spice is not added so abundantly as to overpower the true flavor of the Agaric. A careful cook will keep back a little of the simple boiled liquor to guard against this danger; a good one will always avoid it. "Doctors weigh their things," said a capital cook, "but I go by taste." But then, like poets, good cooks of this order must be born so, they are not to be made. (Dr. Bull.)

Procerus a la Provencale.—Steep for two hours in oil, with some salt, pepper, and a little garlic; then toss up in a small stew-pan over a brisk fire, with parsley chopped and a little lemon juice. (Dr. Badham.)

"Comme il est très léger et très délicat, il faut le faire sauter dans l'huile fine aprés l'avoir assaisonné d'un point d'ail, de poivre, et de sel; en quelques instants, il est cuit. On le mange aussi en fricassée de poulet, cuit sur le gril, ou dans le tourtière avec de beurre, de fines herbes, de poivre, de sel, et de la chapelure de pain; on ne mange point le tige, elle est d'une texture coriace." (Roques.)—*Worthington G. Smith, Dunstable, in The Gardeners' Chronicle.*

AN IRON PILLAR IN THE PUNJAB (HINDOSTAN), NEAR DELHI.

"BUT, before passing on, I must first tell you about an extraordinary iron pillar which stands near the base of the Kootub, and to which the city owes its modern name. It is a solid shaft of metal sixteen inches in diameter. It stands twenty-two feet above ground, but there seems to be a difference of opinion among engineers as to the depth to which the shaft is buried. One declares it to be twenty-six feet below ground, while another maintains that it only extends a few feet, and terminates in a bulb like a turnip. In either case it will ever be a marvel how such a massive column could ever be produced at a single forging, and that so early as the third century of our era. It certainly would puzzle our own iron-masters to rival such work without the aid of their modern steam machinery—a power which we can scarcely imagine to have lent its might to these Vulcans of old.

"It is wrought like our finest metal, and shows no symptoms of rust, though it has stood here for many centuries. It bears an inscription in Sanskrit describing it as the 'Triumphal Pillar of Rajah Dhava, A.D. 310, who wrote his immortal fame with his sword.' This, however, is the only record extant of his deeds. There are several other inscriptions on the pillar, but of more modern date.

"The Brahman tradition is that this pillar was erected in the sixth century. Nevertheless, the pillar is now as firm as a rock, and has even resisted the cannon of Nadir Shah, who purposely fired against it. The marks of the balls are, however, clear enough."—*From "In the Himalayas and on the Indian Plains," by C. F. Gordon Cumming.*

CAN A CELESTIAL BODY FALL TO THE CENTER OF ITS ATTRACTION?

To the Editor of the Scientific American:

In asking this question in your issue of Nov. 21, Mr. Whitmore has apparently gotten into a verbal rather than an astronomical difficulty. Were the earth, as he suggests, stopped in its orbit, it would cease to be a *moving* body; and, being acted upon by but the one force, gravity, it would presumably fall directly to the sun, without the violation of Newton's law or any other established physical principle. The first result of such a catastrophe, as your correspondent is probably aware, would be the conversion of motion into heat, and the consequent complete volatilization of the planet. The future of the solar system has always been a fascinating subject for speculation, and has attracted scarcely less interest than its genesis. As many of your readers have doubtless felt the spell of this enchantment, you will perhaps permit me a few lines of your valuable space to direct their attention to a series of wonderfully interesting experiments which have a direct bearing upon the question. These experiments are not new. They have, in fact, the dignity of age, for fully a quarter of a century has rolled around since they were performed for the first time by Prof. Plateau, of the University of Ghent.

The beautiful theory of La Place, which accounts so satisfactorily for the central sun and its attendant planets, had turned the minds of philosophers to a belief in cosmic cycles. A system which bears evidences of its generation may well be conceived, under the operation of the same laws, to be subject to an extension, a limit, and a returning contraction. That theory, told by La Place in his wonderful *Mecanique Celeste*, and now so universally familiar as the nebular hypothesis, imagines the entire solar system to have been at one time a single sphere of gaseous matter in rotation. With an increasing velocity due to partial condensation, the centrifugal force became more powerful than the influence of gravity. Rings of fluid matter were thrown off from the central orb and finally broke, separating themselves into distinct masses and becoming the material of the planets. These in their turn threw out similar rings, such, for instance, as the one we now see surrounding Saturn, which may be expected to separate and form moons revolving around that planet, or the still more familiar object, the moon, which makes its monthly circuit about our own earth. This conjecture of a solar generation—for one cannot, rational as it appears, specify it more definitely—received an apparent experimental demonstration in Prof. Plateau's researches. He conducted a series of investigations upon the figures of equilibrium of a mass withdrawn from the action of gravity, and his results agreed so perfectly with the solar conditions as interpreted by La Place that many were tempted, and not without reason, to follow the analogy further, and to read, provisionally at least, the future of the solar system in a series of phenomena which they believed had repeated its past. The circumstances under which these experiments were made lend to them an additional interest. Prof. Plateau was entirely blind. He had to depend solely upon the intelligence of his wife for the execution of the ingenious plans which his busy brain devised. One may judge that she proved a faithful assistant, for all the world was found ready to listen to the results.

It seems at first sight rather a difficult matter to remove a liquid mass from the influence of gravity. Our experimental laboratory is limited to the surface of a sphere, where the force is necessarily ever present. But though it cannot be escaped, it may be balanced. If an exactly equal and opposing force can be brought to act upon the mass, the problem is solved. If, for instance, the liquid be surrounded by another liquid of identical specific gravity, and with which it does not mix, it will be practically free from the action of gravity. The fat oils are lighter than water, with which, it is unnecessary to say, they do not mix, and are heavier than alcohol. Here, then, are just the materials sought. Prof. Plateau employed a mixture of alcohol and water, made to correspond exactly with the specific gravity of olive oil. This was contained in a glass vessel, so that the phenomena could be easily studied, and the oil introduced into the center of the mixture by means of a long funnel. In repeating the experiments, Prof. Faraday colored the oil green by adding a few drops of a solution of a copper salt, to make its behavior more easily studied. The mass of oil assumed the shape of a perfect sphere. This result had been anticipated, for it was known that a fluid mass under the influence of no force but the attraction of its own particles would take the form of a sphere. It gave confidence to the experimenter, however, inasmuch as it assured him that he had succeeded in producing those conditions which he assumed as the premises in his investigations. A thin horizontal disk, on the end of a vertical shaft, was then carefully introduced into the center of the sphere of oil. With the rotation of the shaft and disk, the mass of oil was gradually put in motion, and assumed the shape of a flattened spheroid. With increased and varying velocities of rotation, a number of the most interesting phenomena were manifested, but I shall venture only to give the general results, lest I occupy too much space. When the velocity had reached a certain point, and the spheroid had become very much flattened, a ring, of circular cross section, separated from the central body and finally broke, forming a number of separate perfect spheres, rotating on their own axes and revolving about the parent orb. So striking was the identity between this behavior and that which we suppose has characterized the generation of the solar system, that the next stages of the experiment were watched with an interest as intense as that which attends a prophecy. Nor was the interest unrewarded. The velocity of rotation was gradually permitted to decline. The circling satellites reduced their orbit, approached the central body, and were absorbed. The end of the experiment presented the same condition as the beginning—one slowly moving spheroid. When the shaft and disk entirely ceased their rotation, the mass of oil lost its motion, and became again a perfect, immobile sphere. The cycle was complete. This is, of course, not a demonstration, it is simply a supposed analogy. Yet the hint of the future which it contains is worthy of attention in the absence of a more plausible hypothesis. There is indeed astronomical ground for believing that the planetary orbits are decreasing with infinite gradation. The path of each solar satellite may be an elliptical spiral, the center of which is the sun.

Should any of your readers care to examine Prof. Plateau's experiments in greater detail than I have felt justified in presenting them, they will find them in the Memoirs of the Royal Academy of Brussels. A translation by Prof. Henry appeared in the Smithsonian Reports for the years 1863, '64, '65.

PORPHYRY DYKE.

Philadelphia, Nov. 26, 1885.

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